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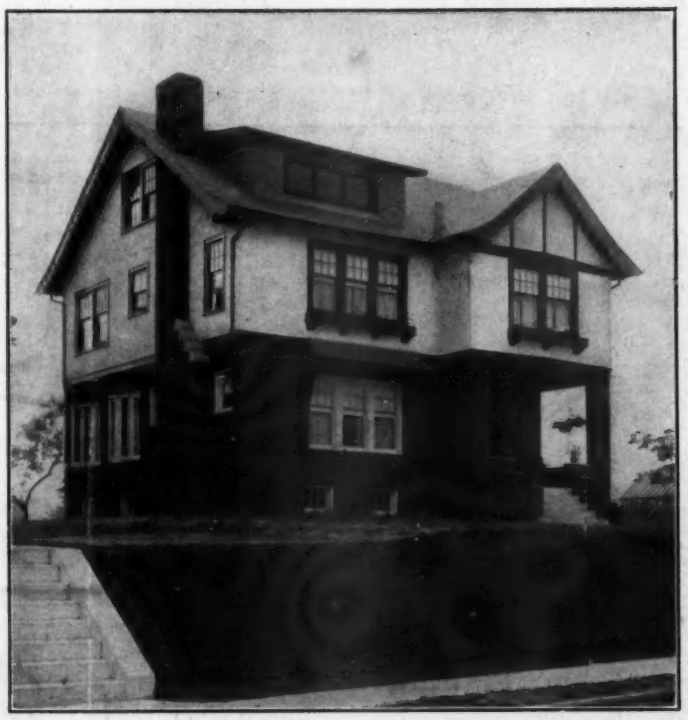

Arch. F. H. Hessenmueller, New York.

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The Gas Machinery Company

Cleveland, Ohio

COAL GAS PLANTS **WATER GAS PLANTS**

BY-PRODUCT MACHINERY

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Vol. CVIII, No. 20 NEW YORK, MAY 11, 1918 Whole No. 3140

Convert Standard Army Coal and Wood Ranges to Gas and Secure Cooking Load at Military Reservation

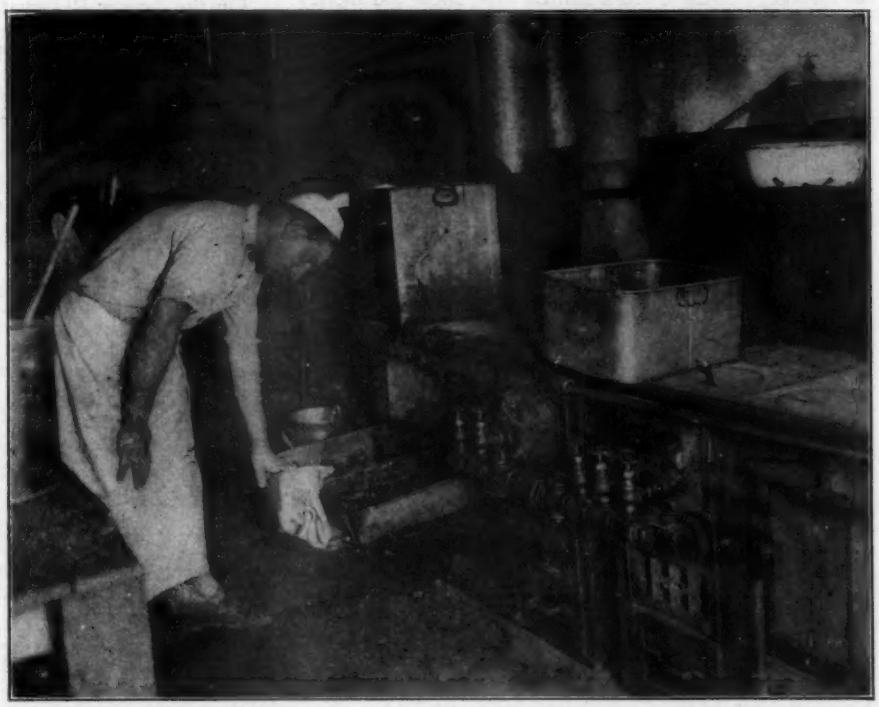
Southern Counties Company of California Looked About to See How It Could Help in the War and Found a Market for Its Product—Cooking and Water Heating the Principal Loads

By CLYDE POTTER
Advertising and Publicity Manager, Southern Counties Gas Company of California

No sooner had our Government declared a state of war existent with Germany a year ago this April than a united America, from our President down to the humblest citizen, began mobilizing for war. Great modern industrial organizations, vast transportation systems, business institutions in every State, financial houses, in a word, the greatest democracy of all time set aside peace pursuits and swung into line for the sterner business of war.

As the biggest news story of a decade trickled over the telegraph wires to the forty-eight States of the Union, the American business man read the dispatches from Washington, took a hitch in his belt and squared himself for his part in the mighty undertaking. Whatever that task might be, manufacturing supplies or munitions, producing foodstuffs, transporting these materials, or shouldering a gun, he was ready for any task Uncle Sam asked of him.

Quick to respond to the Government's call for industrial mobilization were the public utilities of the country. These public service organizations were to figure in every phase of the war work, and they immediately offered their resources, their products, their business experience and their man power to Uncle Sam to do



COOKS AT FORT MCARTHUR ARE WELL PLEASED WITH GAS-FIRED RANGES—NOTE HOW GAS IS CONDUCTED INTO FIRE BOX OF STOVE INTENDED FOR SOLID FUEL

A GAS INSTALLATION IN THE POST HOSPITAL

with it as he saw fit.

The gas companies of the nation have played no insignificant part in the task of making the "world safe for democracy." Aside from contributing men and money they are urged to furnish more coke and coal by-products, toluol, and other elements absolutely essential in modern warfare, where science, chemistry and mathematics have replaced the bow and arrow, the spear and the inferior instruments of former wars. Gas engineers from every section of the country have been in secret sessions in an endeavor to increase the output of by-products for use in war work. Just as the farmer is necessary to food production, the manufacturer to supplies, the railroad man to transportation, so the gas engineer has rendered an invaluable service to the nation in helping to speed up the war program of the Administration.

What a Natural Gas Company Could Do

The Southern Counties Gas Company of California, although not a utility distributing artificial gas, thereby producing materials such as coke, coal by-products, toluol and other materials essential in war operations, has been able to render a valuable service to the nation in time of war. This corporation, now in the eighth year of its existence, distributes natural gas in forty-four cities in southern California. The gas mains of the company, practically 1,000 miles in length, thread three adjoining counties, Los Angeles, Orange and San Bernardino. Manufactured gas formerly was distributed by the Southern Counties Gas Company of California, but this product has been replaced throughout the system by a rich natural gas fresh from nearby oil fields.

But through the medium of distributing natural gas to several Government posts, this company has been able to serve several army and naval bases an extremely valuable fuel for war-time needs. The economy of the gas, its cleanliness and the ease with which it may be handled are but a few of the attractive features which appealed to Government engineers.

To-day the company is serving natural gas to the Government at Fort McArthur, San Pedro, Cal., in both the Upper and Lower Reservations. It is serving gas at the Government Naval Training Station at San Pedro as well as at the Submarine Base in the same harbor. It is serving natural gas to the Los Angeles Shipbuilding & Drydock Company's plant at San Pedro in the work of constructing ships for the Government, and for a time it also served natural gas to the National Guard cantonment at Arcadia, Cal.

The company has been furnishing natural gas at Fort McArthur since July 30, 1917. This applies to both the Upper and Lower Reservations. A high-pressure line was run from the company's main to the fort. All cooking for soldiers at this post is done with Southern Counties gas.

On the Upper Reservation there are ten kitchens, each kitchen having two hotel gas ranges. These twenty ranges furnish ample cooking facilities for the Upper Reservation. In addition to the purely cooking feature, an abundant supply of hot water is furnished for the needs of the men in camp. There are twenty cabinet gas ranges in the officers' quarters for officers' messes.

In the army hospital, located on this reservation, a large Garland hotel range and a large Monarch hotel range are in use. The cook in charge is more than well satisfied with the results of gas cooking as compared with coal or other fuels. In this hospital Ruud tank heaters furnish a supply of hot water.

On the Lower Reservation there are in use ten field kitchen ranges, all of them burning natural gas. They are ordinary field ranges built for wood and coal, but converted into gas ranges. A large number of men live at this lower post, and with the ten gas ranges in operation the cooking is one of the most smoothly operated features of the fort.

Quartermaster a Former Gas Man

Captain Fred D. Baker, formerly new business manager of the Sierra & San Francisco Power Company and of the Coast Valleys Gas & Electric Company, now in charge of the Quartermaster Department at Fort McArthur, made a thorough investigation of the fuel problem before gas became the fuel of this post. Being a gas and electric man by profession, he knew what natural gas would do for his department. He used the regulation army fuel but a short time before changing to gas for cooking and heating purposes.

Captain Baker figured the cost of this fuel as compared with coal, which had been in use there until replaced by gas. He took an average for a company of 109 men and found that the converted regulation army range equipped with a Bunsen burner in one month burned 69,425 cu. ft. of fuel. With the gas costing 40 cents per 1,000 cu. ft., the Government is paying but $27.75 for its fuel. To perform the same work at Fort McArthur 5 tons of soft coal were found necessary. With soft coal at $15.50 a ton, the coal bill amounted to $77.50.

Cost of Fuel per Meal per Man

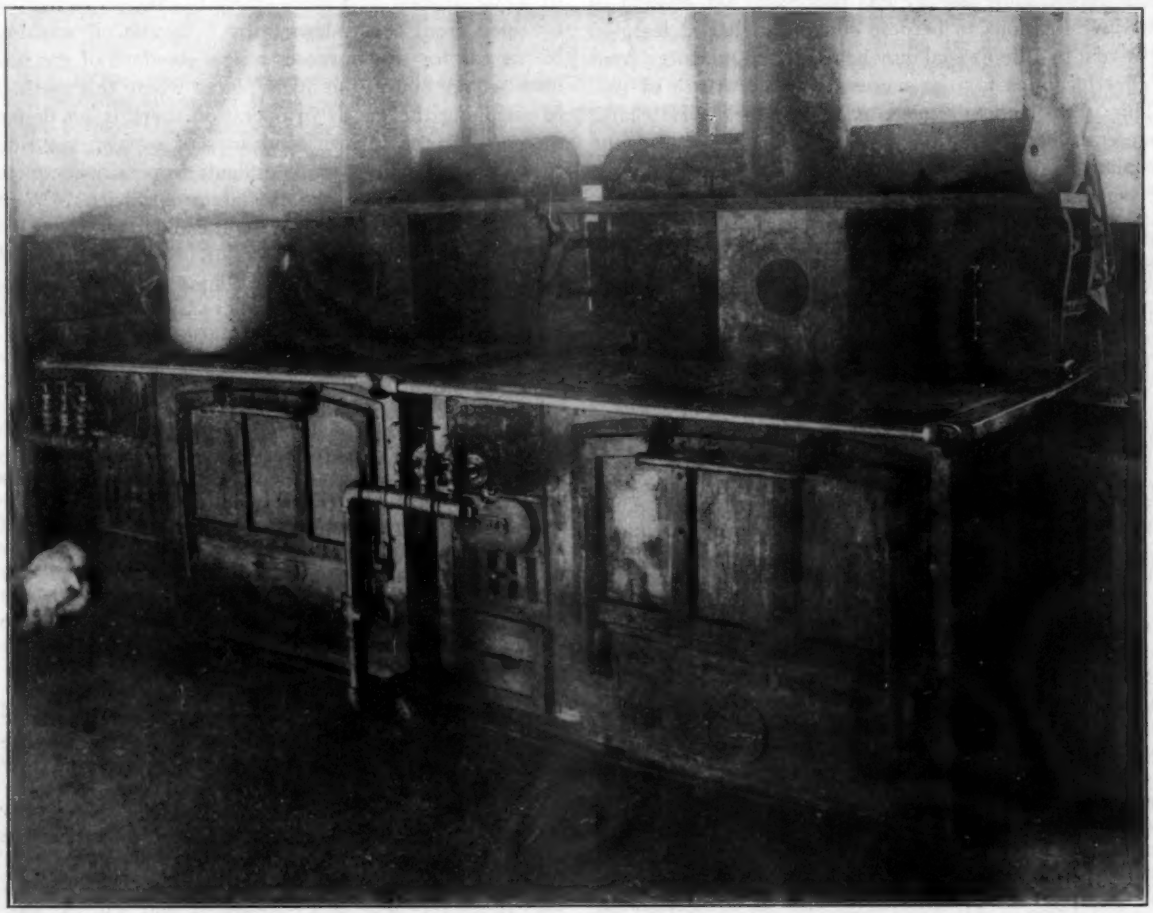
On the army field ranges equipped with Bunsen burners a company of 109 men use each month but 59,300 cu. ft. of natural gas, costing but $23.72, or a little less than a quarter of a cent per meal per man for gas. Comparing the cost of natural gas with coal it was found by Captain Baker that his gas bill amounted to a figure of but one-third of that of his former coal bill. On the regulation army range the gas was $27.75 per month per company, while on the army field range the gas cost dropped to $23.72 per month per company. On the one the gas cost is slightly more than one-third and on the field range less than one-third of what soft coal had cost the Government.

In addition to the marked economy of the gas, Captain Baker found that by equipping his ranges with this fuel the cook saved one hour each morning in preparing the fires in the ranges. This hour may not seem to be a great deal of time saved, but in one month it is thirty hours saved, or more than two working days. The gas was found to be easier to handle. There were no ashes to clean up after each day's work, no soot settled over the kitchen to fall into the dishes. In a word, gas at Fort McArthur has proven to be an ideal fuel, and Captain Baker, supported by every cook at that post, would not consider going back to coal.

At the Submarine Base gas is being used for cooking purposes and for heating water for the men stationed there. In the officers' galley there are two Garland ranges in use, while in the adjoining galley there are four Garland ranges. Four immense steam kettles are used here as food containers. The steam is supplied by an upright high-pressure boiler. Cooks at the Submarine Base are able to turn out a delicious bread, which bakers are selling for 15 cents a loaf, at a phenominally low price of 7 cents, including the gas used.

Natural gas here has facilitated the hot water supply for the needs of all men at the Submarine Base, the capacity being 500 gal. per hour, heated by a cast-iron sectional boiler, automatically controlled by a thermostat. The Hospital Base uses gas heat and in sterilizers, while the foundry is installing the same fuel for the Government forges. The foundry is to have two large furnaces for melting brass and a core oven for all foundry work. It is thoroughly up-to-date and fully equipped, including two furnaces for melting brass, a core oven and a tripple purpose furnace. There are also two blacksmith forges of special construction for the use of natural gas in place of blacksmith coal.

At the Naval Training Station in San Pedro gas is used to bake bread daily. A large number of men are in training at this important base, and only the best of baking facilities are demanded. An abundant supply of



VIEW GIVES AN EXCELLENT IDEA AS TO HOW THE RANGES WERE CONVERTED

hot water is furnished at this station through the medium of a Ruud automatic hot water heater. Three 7-ft. ranges are used for cooking and baking purposes.

The Southern Counties Gas Company of California also is furnishing gas for the Los Angeles Shipbuilding & Drydock Company, located at the same port, San Pedro. This great industry, organized last year to build ships for Uncle Sam's growing fleet, is employing upwards of 6,000 men. Gas, accordingly, is an indispensable product for fuel purposes in this immense plant, replacing all other fuels with the exception of a small amount of coal for use in the portable cranes. All rivet-heating furnaces, blacksmith forges and other heating furnaces used for bending purposes are equipped especially for the use of this fuel. The Government engineers have found that by the use of gas greater speed, flexibility and reliability is secured in the operation of this great plant.

Use of Large Proportion of Local Coals No Longer Experimental in Illinois

The use of large proportions of Illinois coal no longer is experimental. In fact, a committee appointed for the purpose at the last annual convention of the Illinois Gas Association already has proceeded far enough in its investigations to become convinced that at least 50 per cent of Illinois coal may be used with mixtures from other localities for the successful manufacture of gas. This is the announcement made by Horace H. Clark, secretary both of the Illinois Gas Association and of the committee that has this matter in hand.

Such findings by this committee are of great importance, especially in view of the fact that the Federal Fuel Administration recently issued an order prohibiting the shipment of Pocahontas and other known superior gas-making coals from the Eastern fields to Illinois and the surrounding territory. The same regulations prescribed the use of Illinois, Indiana and western Kentucky coal in all steam making.

Where it is shown that the higher grades of bituminous coal are absolutely necessary because of the equipment of certain plants or for other reasons, permits for the use of such coal may be obtained. But even in advance of the announcement of the Federal coal restrictions the sentiment at the recent Illinois convention was that sooner or later during the period of the war Illinois gas companies would be compelled to get along entirely without Eastern coal.

The committee which is investigating to what extent Illinois coal may be used for gas making includes besides Mr. Clark, C. W. Bradley, E. H. Taylor, F. W. Bedard, R. B. Harper, H. O. Shannon. Discussing the findings of this committee the *Public Service Lumen*, the house organ of the Public Service Company of Northern Illinois, says:

"Numerous actual runs on this mixture have already been made in various plants throughout the State. Results in individual cases strengthen the view that even more than 50 per cent of the Illinois coal may be placed in the mixture.

"The physical constitution of Illinois coal, speaking of it as a whole, includes a high sulphur content, a deficiency in gas constituents and in by-products, and an inability to lend itself to coke making. None of the qualities necessary to gas making coal are absolutely absent, but they exist in a very much less degree than in the case as to Pocahontas grades. The use of Illinois coal therefore, in the present knowledge of it, will produce no economies to the gas plants. It may be regarded at present as an expediency or rather as a measure enforced by war conditions. But it is not to be denied that a good deal may be learned about it in the actual practice which has been inaugurated.

"The operations in progress are being followed with close attention by all the gas companies in the State."

Asserts That Gas Coke Has Been Found Not to be Suitable Fuel for Domestic Use

After the war both money and material will be scarce and dear, and it will be for gas engineers to consider whether new works or alterations to existing plants with improved methods and higher efficiency should be adopted to meet the requirements of the future, is the opinion of R. W. Cowie, expressed at the informal meeting of the Scottish Gas Managers, held recently at Glasgow. Every source of economy must be tapped, every source of waste stopped, and every ounce of efficiency must be obtained from every department. By the oil washing of the gas for war purposes a new standard of gas has been set up, and in the many places where this method of stripping the gas is in operation there is no desire to return to the former conditions of supplying a rich gas, with which it is more difficult to obtain complete combustion and to get the maximum of efficiency. Are gas undertakings to go back to the old wasteful ways or to continue along the avenue of progress so quickly opened up by war conditions? The former is unthinkable, and the latter imperative. Close investigation should be made to determine the most economical standard of quality of gas which should be made and distributed. There is need here for research, and that there is room for definition there was little doubt.

The day will come, and might come sooner than many expect, when it will be almost a crime to burn bituminous coal in an open grate, and when gas fires will be universal. Before such an ideal condition could be arrived at, gas engineers must put more thought and investigation into the problem of procuring a fuel after the form of coke, where a solid fuel was required, but lacking the disadvantages of coke. In every gas works there might be a section of the works devoted to the production of this commodity of coke, coalite, smokeless fuel, or whatever it might be called, and the gas obtained will be the by-product of this section.

It is evident that gas coke, as sold is not a suitable fuel for domestic use, or there would not be the immense stocks in various parts of the country which they saw to-day. The recent inquiry by the Coal Controller pointed to the certainty that he would insist on coke being used in steam boilers, etc., in towns where there are large stocks, and thus prevent coal being brought in, and so further his policy of saving railway transit. This is only proper and reasonable, and will be welcomed by gas works having stocks of coke.

No Doubt that Gas-Fired Boilers Have Greater Future To-day than Ever Before

T. M. Hunter Discusses Economy of Using Blast Furnace, Coke Oven and Producer Gas for Steam Raising—Gas-Raised Steam Versus the Gas Engine for Power Generation

Gas as a boiler fuel was first used in connection with blast furnaces somewhere about the middle of the last century, declared T. M. Hunter, in a paper read before the British Institution of Electrical Engineers. Gaseous fuel is apparently the ideal fuel for boiler firing. It requires no stoking and no cleaning of fires. A whole battery of boilers can be attended to by one man, and a constant load is maintained independent of the efforts of manual labor.

The main reason why blast furnace gas has not been used with greater success is that it carries huge quantities of dust. This is deposited in the boiler flues, resulting in a constant decrease of the evaporation and requiring to be cleaned out every few weeks. Under these circumstances, the possibilities of the fuel were not realized. About twenty-five years ago, gas-cleaning plants were introduced, which provided cleaned gas and did away with this disadvantage.

Introduction of the Regeneration Coke-Oven Plant

The introduction of regeneration coke-oven plants next provided quantities of gas, which was also used for boiler firing. On account of the higher calorific value of coke-oven gas, very much smaller quantities had to be handled in order to obtain the same results from boilers. It was found that this gas could be brought into contact with the walls of boiler flues without being extinguished, and so brick-lined combustion chambers were not generally used for its combustion. It was, however, found that even with this richer gas the efficiency of gas-fired boilers was still very low.

The theory gained ground that gaseous fuel was unsuitable for boiler firing, and that it was impossible with it to obtain anything like the efficiency or the evaporation obtainable in the same boiler by coal firing. This theory is still held by many engineers. It is the more surprising that it should have taken such a strong hold, as at the same time the most perfect combustion arrangements were invented for small quantities of gas. We generally connect these improvements with the name of Bunsen, and the Bunsen principle is at the back of most of the work that has been done on large volumes of gas, as well as on small volumes.

The By-product Producer

About twenty years ago the Mond by-product producer, followed by other producers, provided another source of gas in large quantities, and in some cases this gas was used for boiler firing. The author thinks that in no case yet has gas firing of boilers with by-product producer gas been made a commercial success, as it has been found that steam could be raised more cheaply from the coal direct, even after allowing for all the income from the sale of by-products. He does not wish to be misunderstood in saying this, as he firmly believes that there are modern producer and boiler plants even now on the market which can make the gasification and gas-firing proposition a commercial success under suitable conditions.

Many engineers came to the conclusion that they would have to give up boiler firing with by-product producer gas as commercially impracticable, and they turned their eyes to gas engines to utilize the gas economically. Gas-cleaning plants had made the use of producer and blast-furnace gas possible in gas engines. It was soon seen that gas engines would produce 1 hp. for at most 10,000 B.t.u. in the gas. This was at a time when it was assumed that some 20 lb. of steam per horsepower were required in a good steam engine. As this represented over 19,000 thermal units in the steam, and as this steam had to be generated in gas-fired boilers at not more than 50 to 60 per cent efficiency, the gas engine apparently was to be the engine of the future. Probably this would have been found true, but for the adoption of steam turbines, which have reduced the steam per horsepower to about 10 lb. It was also found that the power per horsepower taken by gas engines increased rapidly as the load was reduced, whereas in turbines this was not the case. Turbines could be overloaded without danger, they could be made in units of very much larger size than the largest gas engines, and they were found, unlike gas engines, to be more economical in the larger sizes.

In initial cost the turbine plant was cheaper, and in reliability and in cost of maintenance the gas engine was a very long way behind. It became evident that if gas-fired boilers could raise the steam at 75 per cent efficiency the results from a modern turbine set would be as good as those from a gas-engine set, while as regards reliability and the skilled attendance required, the steam turbine was unquestionably first.

There is no doubt that gas-fired boilers have now a greater future than ever. Probably the time is not far distant when our present method of burning coal together with its valuable by-products will be considered obsolete, and possibly even illegal. It will then be replaced by some type of by-product producer or coal distillation plant yielding gas, and this gas will without doubt be largely used for boiler-firing purposes.

Calorific Value of Gas

The calorific value of gas is expressed as the number of B.t.u. contained in a cubic foot, or the number of calories contained in 1 cu. m. of the gas. It is the custom to quote the calorific value of a gas at normal temperature and pressure. In this country, we quote the number of B.t.u. in 1 cu. ft. as 60 deg. Fahr. and 30 in. mercury column. On the Continent, normal conditions are 0 deg. C. and 760 mm. mercury.

In almost every case where gas is burned for practical purposes the water vapor arising from the combustion escapes to the chimney as a vapor and is not con-

densed. It has therefore become the custom to treat the latent heat lost through the non-condensation of this water vapor, not as a charge against the boiler but as a charge against the gas itself. The "net calorific value" of a gas—which is the value generally quoted—is the gross calorific value, less the latent heat of the water vapor of combustion.

If in any special case the products of combustion are cooled down so far that some of this water vapor does condense, a calorific value would have to be used, otherwise the results shown would be quite deceptive.

To calculate the calorific value from the analysis of a gas, we multiply the volume of each constituent by the calorific value of this constituent and add together the results. The following table shows the calorific values of the common constituents of gas, and an example is added to show the method of using the table. All the calorific values are taken at 0 deg. C. and 760 mm:

	Gross Calorific Values		Net Calorific Values	
	B.t.u. Per Cu. Ft.	Calories Per Cu. M.	B.t.u. Per Cu. Ft.	Calories Per Cu. M.
Carbon monoxide, CO	344	3,062	344.0	3,062
Hydrogen, H_2	342	3,042	293.5	2,613
Methane, CH_4	1.063	9,460	966.0	8,598
Ethylene, C_2H_4	1,724	15,300	1,627.0	14,480
Hydrogen sulph., H_2S	659	5,860	619.0	5,513

Calorific Value of a Coke-Oven Gas

Analysis Per Cent		Net Calorific Value	
H_2	= 49.1	0.491 × 2,613 =	1,282
CH_4	= 32.6	0.326 × 8,598 =	2,800
C_2H_4	= 3.1	0.031 × 14,480 =	449
CO	= 8.1	0.081 × 3,062 =	248
N_2	= 6.6		
O_2	= 0.5		4,779 calories per cu. m.
	100.0		= 537 B.t.u. per cu. ft.

The question of gross or net calorific value of the gas often leads to misunderstandings. It is evident that when gas is produced from coal in a coke oven, or producer plant, the steam actually raised in boilers, per ton of coal put into the plant, is not affected, whether we talk about the gas by its higher or lower calorific value. It is only when we investigate the efficiency of the various parts of the plant that this question arises. The maker of the producer naturally wishes to use the higher calorific value of the gas so as to show a high producer efficiency, while the makers of the boiler and combustion arrangement wish to use the lower value because the difference between the two values is a loss which is not recoverable in the boiler. It is advisable in all contracts that it should be clearly specified which value of the gas is to be used, so as to avoid any possibility of friction.

Below are indicated the losses arising from the latent heat of this water vapor in the case of several typical gases, and suggestions are made as to the possibility of reducing these losses. In all the calculations given in this paper the net calorific value of the gas is the value used.

Value of Gas

Among the by-products recovered from the distillation of coal, the manufacture of iron, the destructive distillation of coal and other processes, gas takes a very important place, and a much more important one than is generally realized by those who receive huge volumes of gas as a necessary and certainly welcome result of processes which primarily were not started for the purpose of manufacturing gas. It is common knowledge that in many modern manufacturing processes a very large proportion of the profits must of necessity be derived from by-products; it will therefore be worth while to consider more closely the value of gas when used under boilers.

Coke-Oven Gas

Let us assume a coke-oven plant of fifty by-product ovens which deals on an average with 100,000 tons of coal per year and yields 6,000 cu. ft. of surplus gas of 450 B.t.u. per ton of coal. Let us further assume that this gas is burned with the assistance of a suitable combustion arrangement, giving an efficiency of 80 per cent. It would then be possible to generate 220,000,000 lb. of steam from and at 212 deg. Fahr., which corresponds to 96,500 tons of steam per year.

Blast-Furnace Gas

The question of gas efficiency for the iron works owner is a still more important one. It can be taken for granted that of the heat generated in a blast furnace 50 per cent is consumed by the process of making iron, and that the other 50 per cent is recovered in the blast-furnace gas.

Part of this gas must be used for heating the blast, but by far the greater part is available for the gas-fired boilers, gas engine and the like.

If the stoves consume 30 per cent of the surplus gas, and if 10 per cent be allowed for losses through bell lowering, 60 per cent is available for boiler firing.

Let us assume that a ton of coke is equivalent to 27,800,000 B.t.u.; then 13,900,000 B.t.u. per ton of coke will be available in the gas; and if 60 per cent of that is surplus for boilers and gas engines, 8,340,000 B.t.u. can be burned under boilers.

If we again assume a boiler efficiency of 80 per cent, 8,340,000 B.t.u. would give 3.13 tons of steam at 100 deg. C. per ton of coke.

Producer Gas

Very few people at present use producer gas for boiler firing. On the other hand, at many works there are considerable amounts of waste products, like belt pickings, coke breeze, shale, etc., which are very rich in combustible matters and yet unsuitable for boiler-firing purposes. Any proposition would be welcome which would render it possible to turn these waste products to profitable account without endangering the stability of the steam supply.

The fallacy of a producer-gas proposal for boiler firing without absolute security of the results obtained in the boilers is evident if the following figures are taken into consideration. A modern producer will yield nearly 75 per cent of the heat contained in the fuel

as heat in the gas, and with the old combustion arrangements hitherto in vogue no higher efficiency than 50 per cent can be counted on, so that only 37½ per cent of the heat in the fuel appears as heat in the steam.

If we take a fuel containing 12,000 B.t.u. per pound, the total steam raised in a gas-fired boiler per pound of fuel in the producer would not exceed 4½ lb. from and at 212 deg. Fahr. Then, again, 1½ lb. of this had to be returned to the producer in the blast, so that the net evaporation for outside purposes was only 3 lb. per pound of fuel. Under ordinary circumstances the same fuels fired into boilers would have given 7 or 8 lb. of steam per pound of fuel. With modern combustion arrangements an efficiency of 50 per cent with producer gas can be raised to 75 per cent. so that fuel of 12,000 B.t.u. will give 7 lb. of steam per pound of fuel; and as with the latest by-product recovery producers the steam necessary for producing by-products has been reduced to the amount necessary to drive the blowers, etc., the actual yield would be over 6½ lb. of steam per pound of fuel. The result in steam for outside purposes is not materially worse than if the fuel had been burnt in the boilers, and the by-products are available to provide for depreciation, interest and profit.

Suitability of Gas for Boiler Firing

Coke-Oven Gas.—Coke-oven gas gives comparatively higher efficiencies than the two other kinds of gas in gas-fired boilers owing to the greater ease with which it can be burned. The nature of the gas, however, renders it difficult to make burners which will deal with large quantities of gas. The comparatively narrow flues of Lancashire boilers offer so much resistance to a speedy expansion of the burning gas that unless we use forced draught the evaporation from coke-oven gas in Lancashire boilers is confined to 5,000 to 6,000 lb. per hour. If, therefore, new boilers are contemplated it will always be advisable, provided that the quality of the water permits it, to choose water-tube boilers. Coke-oven gas is particularly suitable for firing water-tube boilers, and with suitable combustion arrangements evaporations of 5½ lb. per square foot of heating surface can easily be obtained at the highest efficiency.

Blast Furnace and Producer Gas.—Blast furnace and producer gas, though of comparatively low calorific value, provided that they are clean and supplied under suitable pressure, will give good results both in Lancashire boilers and in water-tube boilers. With Lancashire boilers evaporation of over 8,000 lb. per hour can be obtained, and with water-tube boilers 5 to 5½ lb. per square foot of heating surface.

Blast-furnace gas we have to accept as it comes from the furnaces. It is so important that the iron made should be exactly what is required that the kind of gas produced is never likely to be a matter of much concern to the blast-furnace manager. We must accept the fact that occasionally the gas is hardly combustible at all, and we must devise means to deal even with this condition.

The matter is different in dealing with producer gas. Gas is here a valuable product, though only the second product in point of value. The manager of the producer has it in his power to give us a gas which is much more or much less suitable for boiler firing. We naturally wish the richest possible gas, as it is the easiest gas to burn. At one large Mond plant the gas was found to be just 100 B.t.u. per cubic foot, while at many plants the gas is over 150 B.t.u. per cubic foot.

Apart from the question of calorific value, there is the question of the constituents of the gas. Two gases of similar calorific value can be shown which would give very different results on combustion. By-product producer gas, as is well known, is made by blowing steam and air blast into the producer fire, and the resulting gas contains hydrogen and CH_4. These gases, on burning, form, respectively, 1 and 2 cu. ft. of water vapor per cubic foot of H_2 and CH_4, and the latent heat absorbed in forming this vapor, viz., 966 B.t.u. per pound of vapor, is at present due to the inevitable losses in the use of the gas. The only way in which this heat could be recovered would be by cooling the chimney gases sufficiently to condense the water vapor, and this is impossible with our present economizers. To show the losses which are inevitable from this cause, the author gives the analyses of several gases, the net calorific value, and the number of B.t.u. lost by latent heat in the water vapor caused by combustion:

	Coke-Oven Gas Per Cent	Blast Furnace Coke Gas Per Cent	Moore Producer Gas Per Cent	Mond Producer Gas Per Cent
CO_2	...	12.0	12.7	16.0
CO	8.1	29.0	15.5	8.0
H_2	49.1	1.5	20.2	23.4
CH_4	32.6	0.7	2.2	3.2
C_2H_4	3.1	...	...	...
N_2	6.6	56.8	49.4	49.4
O_2	0.5	...	0.2	...
	B.t.u.	B.t.u.	B.t.u.	B.t.u.
Calorific value (cold gas)	540	112	132	130
Loss by latent heat in vapor of combustion	58½	1½	12½	17

These analyses of gases, as in the case of any other analyses given in the paper, must be taken only as examples. They are analyses of gases with which the author has actually had to do, but it is well known that even on the same plant analyses of gas vary greatly from time to time.

This table shows the great value of the losses from this cause. The author has purposely chosen two producer gases of similar calorific value in order to bring out the point that a gas is more valuable for boiler firing or for combustion in any way which has a greater proportion of CO to H_2, other things being equal. Producer buyers should look carefully into this point when specifying new plant. A certain amount of steam must be blown into the producer in order to recover the ammonia, but at present far more is used than the amount necessary for the purpose in order to cool the fire. The author believes that some other method should be adopted for this cooling. The Moore producer, mentioned above, does part of this cooling by means of a water jacket. It has been suggested that much of this cooling could be done by some method such as by blowing in boiler flue gases carrying, say, 15 per cent of CO_2, and taking advantage of the absorption of heat which occurs when CO_2 is reduced to CO in the presence of heated carbon. This is known to America as the Eldred process. In this way the gas should be improved and

much steam saved. The question, however, is still in the region of experiment.

Drying and Cleaning Gas

It is very important that the gas should be dry when burned. At any temperature from 0 to 100 deg. C. gas will take up a known amount of water as vapor, and this amount can be found in an air-saturation table. If the gas has been cooled or washed in water, it is reasonable to assume that it is saturated with water to the amount corresponding to the lowest temperature to which the gas has been brought. As an example of the amount of water carried in this way, the author had recently to use, at 15 and 55 deg. C., respectively, the two producer gases described in the above table. The former gas carried under 2 per cent by volume of water vapor and the latter carried 15½ per cent. This vapor must all be heated when the gas is burned, and it not only lowers the flame temperature, but also is responsible for carrying to the chimney a large quantity of sensible heat.

To show the actual loss from this cause, let us assume that we have cleaned blast-furnace gas from the same furnace, in one instance at atmospheric temperature, with 12 to 15 grammes per cubic meter of water vapor, and in the other instance gas saturated at 70 deg. C. carrying about 362 grammes per cubic meter. The analyses of the gas at 0 deg. C. and atmospheric pressure is:

Per Cent	Calorific Value
$CO = 29$	
$H_2 = 3$	965 calories per cubic meter.
$CO_2 = 8$	107 B.t.u. per cubic foot.
$N_2 = 60$	

In both cases the gas is to be burnt under boilers with an excess of air of 25 per cent.

We have to ascertain, first of all, the air necessary for the combustion of this gas without excess of air, which is shown by the following table in cubic meters:

	1 Cu. M. of Gas	Oxygen Needed	CO_2	H_2O	N_2
H_2	0.03	0.015	...	0.03	...
CO	0.029	0.145	0.29	...	...
CO_2	0.08	....	0.08	...	...
N_2	0.60	....	...	...	0.60
	1.00	0.160	0.37	0.03	0.60
Air required:					
$0.160 \times 4.77 = 0.762$ carrying N_2					0.60
Total N_2 ..... (cu. m.)					1.20

25 per cent excess of air, $0.762 \times 0.25 = 0.19$ cu. m.

The combustion temperature of this gas when burnt with an excess of air of 25 per cent is 1,320 deg. C., found thus, using the Le Chatelier formula:

$$\text{Air and } N_2 = 1.39 \times (0.303t + 0.000027t^2)$$
$$H_2O = 0.03 \times (0.34t + 0.00015t^2)$$
$$CO_2 = 0.37 = (0.37t + 0.00022t^2)$$
$$\text{Total, } 0.568t + 0.000124t^2 = 965$$
$$t = 1{,}320 \text{ deg. C.}$$

Now take the gas at 70 deg. C. Its temperature is about 55 deg. C. higher than atmospheric temperature, so that the additional sensible heat per cubic meter is 3 B.t.u. This raises the calorific value of the gas to 110 B.t.u. To this must be added the heat in the water vapor accompanying the gas, so that the calorific value of the gas plus the water vapor will be 113 B.t.u., or 998 calories; 1 cu. m. of aqueous vapor at 70 deg. C. weighs 644 grammes; 1 cu. m. of water vapor at 0 deg. C. = 810 grammes; at 70 deg. C. $\frac{810 \times 273}{273 + 70}$ so that 362 grammes of vapor carried by the gas will correspond to 0.562 cu. m. (0.445 cu. m. at 0 deg. C.), and the combustion temperature is found thus:

$$\text{Air and } N^2 = 1.391 \ (0.303t + 0.000027t^2)$$
$$H_2O = 0.475 \ (0.34t + 0.00015t^2)$$
$$CO_2 = 0.37 \ (0.37t + 0.00022t^2)$$
$$\text{Total, } 0.72t + 0.00019t^2 = 998$$
$$t = 1{,}090 \text{ deg. C.}$$

This shows that there is a drop of 230 deg. C. in the combustion temperature, which, of course, is a very serious matter. It is much more difficult to obtain complete combustion of this mixture of aqueous vapor and gas with an excess of air of 25 per cent than if gas alone is dealt with. It is also a well-known fact that the efficiency of a boiler depends, in the first instance, on the initial temperature of combustion, and if the latter is lower the efficiency of the boiler is certain to decrease. The first thing to be affected will be the evaporation per square foot of heating surface, which is certain to be considerably smaller if wet gas is used than with dry gas.

We have next to consider the effect of the water vapor on the efficiency of the boiler. From our former calculations the formula representing the loss is, in the case of the dry gas, $0.568t + 0.000124t^2$, and in the case of the wet gas $0.72t + 0.00019t^2$.

Let us assume that it would be possible to burn completely the dry and the wet gas with an excess of air of 25 per cent, and to pass the waste gas to the stack in both instances at a temperature of 250 deg. C. The losses through waste heat in the case of dry gas would be $0.568 \times (250 - 15) + 0.000124 \times (250^2 - 15^2) = 142$ calories, and in the case of the wet gas $0.72 \times (250 - 15) + 0.00019 \times (250^2 - 15^2) = 180$ calories per cubic meter of the gas burned. The loss through waste gas for dry gas would be 14.7 per cent of the total value of the gas, and for wet gas 18.7 per cent. Or, in other words, the presence of the water in the gas will cause an unavoidable and irredeemable loss of 4 per cent in addition to the loss by the reduced flame temperature. Assuming in both cases 10 per cent loss through radiation and conduction, the actual efficiency for dry gas would be 75.3 per cent, and for the wet gas 71.3 per cent, which is equivalent to a drop in the output obtainable from the same quantity of gas amounting to 5.3 per cent.

Let us assume that in both cases the boiler is working on its maximum load; that is to say, that the boiler flues pass the maximum quantities of gas and air which the chimney draught can convey at the most favorable position of the damper. Let us assume that we are dealing with a 30 x 8 ft. Lancashire boiler, and that with a dry gas under the above described circumstances the highest possible evaporation was 6,000 lb. of water from and

at 212 deg. Fahr. As the total efficiency of the boiler is 75.3 per cent, the total quantity of gas necessary in order to provide this evaporation contains 7,700,000 B.t.u. At 107 B.t.u. per cubic foot, 72,000 cu. ft. of gas must be burnt per hour in order to obtain this evaporation. It was found above that for each cubic foot of gas 0.952 cu. ft. of air are necessary for complete combustion with an excess of air of 25 per cent. The air passed through the boiler will be 69,000 cu. ft. per hour. In order to facilitate our calculation let us assume that the weights of the gas and the air are the same. Then the total weight of 141,000 cu. ft. of air and gas will be 141,000 × 1.293 oz. = 11,400 lb., which represents the total weight of products of combustion that the boiler can possibly pass. Now at 70 deg. C., each cubic foot of gas carries 0.0228 lb. of water, while the weight of the products of combustion from each cubic foot of dry gas will be 1.975 × 1.293 oz.= 0.158 lb. The weight of the products of combustion of wet gas is increased by 0.0228 lb. for each cubic foot of gas, giving a total weight of 0.1808 lb. for each cubic foot of dry gas plus water. The boiler is not capable of passing more than 11,400 lb. per hour, so that the maximum amount of gas to be dealt with would be 11,400 ÷ 0.1808 = 63,000 cu. ft. per hour. The total calorific value of the hot gas is 113 B.t.u. The total heat admitted is 63,000 × 113, or 7,100,000 B.t.u., the possible efficiency as above is 71.3 per cent; the heat of the steam is, therefore, 5,050,000 B.t.u., which corresponds to 5,240 lb. from and at 212 deg. Fahr.

This somewhat lengthy calculation is useful, as it shows that the simple presence of water in the gas can, under otherwise absolutely equal conditions, result in:

(1) A drop of efficiency of 5.3 per cent.

(2) A drop in evaporation of 12.7 per cent.

(3) The loss due to lower flame temperature, which the author has not attempted to calculate.

From these calculations it is evident that an engineer who has to specify a producer plant, or a gas-cleaning plant, where washing of the gas is part of the process, should take care to specify the maximum amount of water vapor allowable in the gas supplied.

Contrary to a frequently expressed opinion, the author does not believe that the dust in itself impairs seriously the heating value of blast-furnace gas, and the uncleaned gas has the advantage that it contains the sensible heat. The dust, however, may seriously affect the efficiency of the boiler. If two Lancashire boilers are run side by side, the one on cleaned and the other on uncleaned blast-furnace gas, it will be found that at first the results as regards both evaporation and efficiency are about the same. Soon dust will start to accumulate in the boiler flues, and as this dust is an insulating agent, it will impair both the evaporation and the efficiency. After four or six weeks the dust accumulates in such large quantities that the evaporation falls, and combustion may even take place partly in the stack instead of under the boiler. Where Lancashire boilers are to be fired, it will, therefore, generally pay to install a gas-cleaning plant, even at the expense of the sensible heat which is lost in the cleaning process.

Conditions are much more favorable with water-tube boilers, as with these it is often possible to clean the tubes without stopping the boiler. If liberal use is made of the steam lance, the proposition to put in a cleaning plant will certainly not be such a favorable one as in the case of Lancashire boilers.

It is not proposed here to enter into the advantages and disadvantages of the various systems of dry or wet cleaning. The ultimate choice in each case will depend on the first cost of plants and on the cost of attendance and maintenance. Heavy charges are involved for power consumption and for interest and depreciation on the capital outlay. But, whatever the cost should be, it must be borne in mind that the cheapest plant is not worth having unless it fulfills the following conditions:

(1) The gas must be clean.

(2) It must be dry, and this is even more important than the cleanness.

In some cases where the gas can be cooled to a temperature of 80 deg. C. without water injection, and where the ores contain only a small percentage of moisture, it is possible with a dry-cleaning plant to obtain a dry, hot gas; whereas, where wet-cleaning processes are used, or where water is injected for the purpose of cooling the gas, the gas is saturated, and this water has to be eliminated.

The sensible heat in blast-furnace gas per cubic foot is approximately as follows:

Temperature of gas, 200, 250, 300, 350, 400 deg. C.
Sensible heat, 7, 9, 11, 13, 15 B.t.u.

As cold blast-furnace gas varies from about 90 to 110 B.t.u., this sensible heat is a large percentage of the total heat of the gas. Firing water-tube boilers with properly designed burners and using the steam lance, say, twice a day to clean the tubes, the efficiency with uncleaned gas is certainly within 10 per cent of the efficiency with cleaned gas—probably within 6 per cent. On the other hand, with Lancashire boilers the average efficiency over four or six weeks with uncleaned gas is very considerably lower than with cleaned gas.

The decision as to whether it will pay to clean gas must therefore be made for each case separately, and depends on the peculiarities of the gas and of the dust, as well as on the kinds of boilers used.

Heat Transfer

Gaseous fuel, as usually burned, does not give the intense local heat and the heat-radiating surface of the coal fire. Rather the problem is that of a very hot gas which is cooled gradually as it travels through the boiler. It is like the problem of a coal-fired boiler with the fire grate entirely outside.

The transfer of heat through a steel wall from hot gases to water consists of three parts—transfer of heat from gas to metal, transfer of heat through metal, transfer of heat from metal to water. The resistance to the transfer of heat in the second and third parts is exceedingly small when compared with the resistance to the transfer of heat from gases to metal. It is calculated for one case that the resistance to transfer of heat from gas to metal was 622 times the resistance to heat passing through the steel.

This shows that the advantage to be gained by fitting, say, copper tubes instead of steel would be very small indeed. Again, the transfer from metal to water, if the metal has a clean surface, is also negligible compared with the gas-metal transfer. If, however, the metal carries scale on its surface the case is very different. Scale ¼ in. thick, assuming the scale to have the same conductivity as plaster of paris, of which the specific resistance to the conduction of heat is 108 times that of iron, would add resistance to heat transfer equal to 18 per cent of the resistance of transfer from gases to steel.

The problem of finding the most satisfactory boiler for gas firing is to be solved by the boiler which abstracts the heat most successfully from the hot gases passing. There are several lines along which improvements can be made.

The first is to increase the surface exposed to the hot gases. The greatest resistance to heat transfer is at the hot surface of the tube, and therefore this hot surface should be increased greatly without necessarily the wet surface. This has been done in some boilers by fixing projecting pieces or rings of angle iron inside the fire tubes to increase the heated surface, and has resulted in a considerable improvement in heat transfer.

The second method depends on the fact that a square foot of heating surface at right angles to the gas flow is about four times more effective than a similar surface at 45 deg. and about eight times more effective than a similar area parallel to the gas flow—at ordinary velocities of gas. Deflectors or retarders, of one kind or another, are put into the boiler so as to cause the gases after they have been fully burned to impinge on the tubes as directly as possible.

A third method, and probably the one most commonly used, is to put surfaces of brick or other refractory material in the boiler in such a way that the flames play upon them. These surfaces are raised to a high temperature and transfer the heat by radiation to the boiler tubes. Such surfaces, in order to give the greatest effect, must face the boiler tubes squarely, and must be as near as possible to these tubes. It is quite easy to heat surfaces at right angles to the line of gas flow, but usually very difficult to heat surfaces in the required position, as they generally have to be parallel to the gas flow. The transfer of heat by radiation becomes much more rapid in proportion as the difference between the temperature of the two bodies concerned increases. From Stefan's law that the amount of energy radiated is proportional to the difference between the fourth powers of the absolute temperatures of the hot body and its surroundings, we can deduce the following table:

Difference Between Hot Body and Its Surroundings	Proportional Amount of Heat Radiated
100 to 0 deg. C.	1.0
200 to 0 deg. C.	3.3
400 to 0 deg. C	12.0
600 to 0 deg. C.	26.0
800 to 0 deg. C.	45.0
1,000 to 0 deg. C.	70.0

This table shows the necessity of raising our radiating surface to the highest possible temperature, and this again points to the use of the highest possible gas or air pressure in our burners in order to shorten the flame and make it more intense.

A fourth method depends on the theory that the difficulty of heat transfer from gas to metal is caused by a thin layer of cooled gas which adheres to the surface of the metal and acts as a non-conductor. The stream of hot gases is made to scour very rapidly the surface of the tubes, and in this way the cooled gas is swept away and fresh hot gas is constantly applied. Very rapid heat transfer has been obtained by this means. In Nicholson's experiment a cylinder 10 ft. long was put into the flue of a Cornish boiler so as to leave a passage between cylinder and flue wall of only 1 in. all around. The gases were drawn through this passage at a velocity of 330 ft. per second by a high suction, probably 20-in. water gauge. They were reduced in temperature from 1,260 to 425 deg. C. in the passage, giving up sufficient heat to evaporate 36 lb. of water per square foot of the tube per hour.

The author has had no experience with the Bonecourt boiler, but it is claimed by the makers that the heat is taken out of the gas by means of surface combustion on blocks of refractory material in the tubes, and that the heat is transferred by means of radiation from this material. Whether or not there is any surface combustion in the process as carried on in their latest boilers, the author thinks it likely that the high velocity of the gases through the tubes, in close contact with the walls and heating the refractory blocks, may be sufficient to account for the evaporation per square foot claimed. The suction required—16-in water gauge for the larger evaporations equivalent to a velocity of about 250 ft. per second—would seem to bear this out. Unfortunately, it is a costly matter to get these high suctions for the very large volume of hot gas with which we have to deal in boiler firing.

It will be noticed that each of these methods involves either the use of power or the insertion of some obstruction in the boiler.

There is no doubt that boiler users object to have any kind of brick erection inside a flue, as it may burn away and require renewal, and it must be removed to clean and inspect the flue. The author considers that for existing boilers the method of increasing the heating surface by the use of some kind of metal fitting in the flues is the one least open to objection. In regard to the use of power for forced draught or suction, it must always be remembered (although it is more usually forgotten), that such power is a charge against the boiler and that its cost must be deducted from the efficiency of the boiler before the net efficiency of the latter can be brought out. In some cases the power involved is quite small. To put the gas——or air—under 2-in. pressure, in the case of blast furnace or producer gas, requires power which would only reduce the boiler efficiency by 1½ to 2 per cent, whereas the additional efficiency attained may be from 10 to 20 per cent.

Wherever high-pressure boilers are to be installed there is little doubt that water-tube boilers will be chosen if the available feed water is soft enough or can be suitably treated. It is important that sufficient combustion space should be provided for the huge volumes of gas to be burned, so that the gas may be fully burned before passing through the tubes. External combustion chambers should be avoided as causing unnecessary losses by radiation and conduction of heat, and because the highest temperature is not attained in the immediate vicinity of the tubes.

A good boiler should evaporate about 80 per cent of the load in the first bank of tubes, 15 per cent in the second, and 5 per cent in the third. The third bank is thus practically an economizer, and this accounts for the fact that the maximum evaporation of water-tube, gas-fired boilers per square foot of heating surface is usually only 5½ to 6 lb. per hour. In a large Stirling boiler fired with coke-oven gas and evaporating 5½ lb. per square foot of heating surface, the temperature of the steam was 290 deg. C., the temperature of the gases leaving the boiler was only 238 deg. C. and the temperature of the feed water was 55 deg. C.

When judging a boiler it will be safe to take the results obtained from coal firing, as we can be certain that

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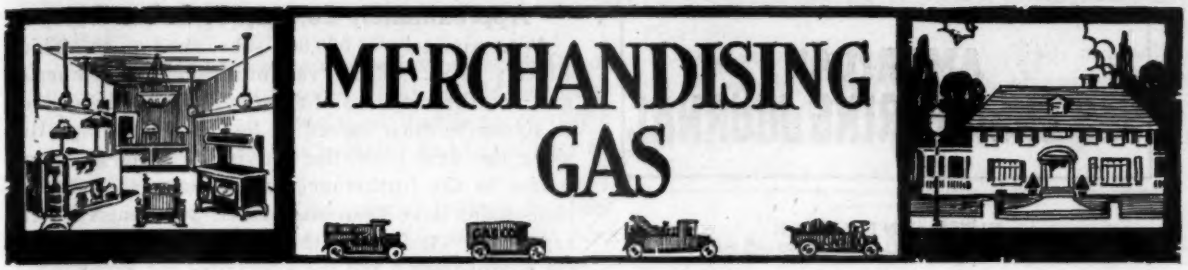

To Be a Good Commercial Man Is To Be Something Well Worth While

H. E. Danner Asserts Proficiency in Commercialism Is as Admirable as Proficiency in Medicine, Engineering or Other Professions—Contends that Best Commercial Men in Public Service Work Are as Well Paid as Good Men in Other Professions

Individual effort when well directed can accomplish much, but the greatest good must necessarily come from the combined efforts of many. Individual effort may be turned to individual needs, but combined effort should be dedicated to the service of mankind. The power of combined effort knows no limitation, declared H. E. Danner, commercial manager of the Houston Gas & Fuel Company, Houston, Tex., in his paper before the Southwestern Electrical and Gas Association.

Influence Felt on Other Departments

Not many years ago this sort of idea was put into practice through the organization of the first regular commercial department known to the gas and electric fraternity. To-day all up-to-date and successful managers realize that these organizations cannot be dispensed with. It is needless to follow their growth. Their deeds stand out more strikingly and convincingly than words could tell. The best impression, to my mind, of commercial organizations since their beginning may be found in the simple and much-used word "Service." Public service corporations have come into closer relationship with the public through the service rendered by their commercial organizations than they ever could have through any other agency. The service rendered by commercial departments cannot be represented all together by dollars and cents. It is another ideal. It is the confidence, good-will, respect and esteem of our fellowman that is most greatly desired, which only sincere service can win.

The introduction of commercial departments with public service corporations is hardly less important than the discovery of the commodities which they sell. Their activities have a tendency to elevate the ideals and standard of employees in other departments, thus creating a spirit of co-operation and personal desire in the life of each individual employee to render better service and do their best to maintain efficiency in their own department.

The service to be performed by the commercial organizations of public utilities can be fully appreciated through the one reason given by Secretary of the Treasury William G. McAdoo, in his recent letter to President Wilson regarding reasons why public utilities should not be permitted to become weakened, wherein he states: "The health and comfort of our citizens in their homes are dependent on them." Commercial organizations have been the trail blazers for all comforts enjoyed to-day, which in turn are conducive of better and more healthful conditions. It is easy to realize the wonderful change in public sentiment brought about through campaigns inaugurated by commercial departments to educate patrons and the public to a point of fully appreciating health and comforts through the use of our commodities. Who is there that can say such manifested interest in the welfare of patrons and citizens will not bring dividends?

Commercial Manager a Teacher

In the analysis of these departments the commercial manager must occupy the position of a teacher, ever striving to inculcate into the minds of his salesmen or representatives the essential qualities which must be developed in order to produce the greatest efficiency. When selecting men who are to reckon with the prospects or customers, he should choose men who possess or who, in his opinion, can be taught certain requisites which should be used as a standard for measuring candidates for public service. Honesty, health, ability, ingenuity, courtesy, tact, sincerity and enthusiasm are the principal and necessary requisites a representative should possess; but above all he should possess enthusiasm. A man might possess all of the other requisites I have mentioned and if he lacked enthusiasm he would be only dead wood in the organization. There is always hope for the man who is doing something, whose activity keeps him keen and alert. The inactive man has no place in the business life of to-day. To be successful a man must be on the job every minute, and the price is not too high considering the great rewards in the way of increased judgment, discrimination, opportunity, etc.

Proficiency in the art of commercialism is as admirable as proficiency in medicine, engineering or other professions. Business is recognizing this fact, because many of the best commercial men in public service work to-day are as well paid as good men in other professions. To be a good commercial man is to be something

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PATENTS PERTINENT TO THE GAS INDUSTRY—PAGE 15 OF ADVERTISING SECTION

Approximately 20,000,000 Subscribers

Approximately 20,000,000 subscribed to the Third Liberty Loan. Of this vast multitude the number of gas men themselves and those whom they influenced to subscribe must indeed be lost in the throng. But since the first issue the activities of the gas companies in the furtherance of the success of the various loans have been augmented at an increasingly rapid rate. And in this thought the gas man can find his compensation for the efforts he has expended.

He has attained the point where he is doing pretty close to all he can do. And none could ask more than the limit of anyone's ability.

It is a moment for brief relaxation, but very brief. This last campaign has taught us some new lessons. We must assimilate them and plan to approach nearer to 100 per cent effectiveness on the campaign which will come at a time none of us yet know.

The AMERICAN GAS ENGINEERING JOURNAL takes with a considerable grain of salt the stories one hears of the demoralizing effect the successes of our loans will have on the enemy's morale. In its opinion a more primitive form of logic is necessary to convince the somewhat peculiar form of mentality that characterizes the Teuton. But the proceeds of these loans provide the wherewithal of administering this more effective form of logic. They are an essential. Also, since the lot of those of us who still wear civilian clothes is so easy comparatively, and buying Liberty Bonds and influencing others to buy them is one thing we can do to make ourselves feel that we are doing something, then surely we should imbibe of this satisfaction to the limit.

The Tendency to Question

An unfortunate condition has developed in connection with the proposed amalgamation of the American Gas Institute and the National Commercial Gas Association, doubtless traceable to the fact that all information was withheld from the field until the complete plan was ready. Various visitors at the office of the AMERICAN GAS ENGINEERING JOURNAL have indicated a tendency to suspect an ulterior motive; some have even inferred that a particular individual had obtained a predominant voice in the preparation of the plan, with the intention, as they expressed it, of "feathering his own nest."

If these men are representative of any considerable faction of the gas industry, the new association, if it is formed, is starting out under a severe handicap. There is already a group of doubters, a group that will suspect the motive behind every movement that is proposed. In paying their dues, if they become members, they will pay them in disgruntlement, figuring they are paying forced tribute to the shrewdness of the individual they suspect rather than

a contribution to the progress and growth of the gas industry.

There is an atmosphere of ward politics created; nothing like the atmosphere that should surround the inception of an association that is to represent the whole American gas industry and to enhance its prestige.

The AMERICAN GAS ENGINEERING JOURNAL has been importuned to take a stand on this matter. It does not propose to do so, as it can see no reason why it should concern itself with individuals. It accepts at its face value the information that has already been published. It cannot believe that any definite conclusions have been reached as to who will constitute the salaried personnel of the new gas association. Otherwise, surely the field would have been informed.

The only salaried position that is of importance sufficient to be made a point of issue is that of secretary-manager. For this office we feel sure that a man of broad gas engineering experience will be selected, for such is the obvious course. It is easily possible for an engineer of the right character to grasp sufficiently the commercial viewpoint to properly discharge his office. It is impossible for an essentially commercial man to grasp the engineering viewpoint.

We believe that the selection of this secretary-manager will not be made by a small group of men and voted in in conventional style. The voice of the field should have a strong influence in his selection. And there—in the voice of the field—lies the crux of the whole situation; the determining factor, if the amalgamation does take place, of whether or not it will be a success or a failure. *The field, the voice of the average gas man, must be heard.*

The prosperity and welfare of the gas industry for some years to come, if the amalgamation takes place, will be strongly affected one way or another by the degree of success attained by this new association, and in the degree to which it has the whole-hearted co-operation of the industry behind it.

Less than three hundred gas companies do not constitute the American gas industry. If the new association cannot hope to attract more than this number, then there is little reason for its existence. Any company will come in if it is profitable for it to come in, and this can only be possible with an association founded on the highest of ideals and having at its service the best developed minds and talents in the industry.

If any man can suggest a better plan than the committee lays down, then it is his duty to himself and to his industry to suggest that plan. If he sees potentialities for harm, or politics, in the selection of the management in the plan as outlined, he should point out such flaws and resist aggressively their adoption.

The meeting to be held on the sixth day of June should not be a sheeps' chorus of passive "ayes." The place for the gas man to speak, if he objects to the plan as proposed, is at this meeting, not in the editorial offices of gas journals.

The Successful Manager of To-morrow

We have seen, as the years have passed, successful managers without number of the driving type, some almost brutally so. So numerous have successful managers of this type been that instinctively we are prone to set down as a future success almost every intelligent young man with a touch of the domineering in his nature that we encounter.

But new discoveries are being made. We are due for an about-face in our perspective. The successful manager of to-morrow will not be harsh-voiced in speaking to his subordinates; instead of following the set rule of never betraying complete satisfaction with any employee's work, he is going to be openly enthusiastic.

At this late day and age we are discovering that the essentials of getting work out of human beings are somewhat different from getting it out of mules. Man requires something more than merely his daily bread as the reward of his labors.

We are heading towards an idealistic age, and the man who would succeed, who would reach the high places, would do well to school himself into the habit of thinking noble thoughts, of including in his estimates not only the extent to which he personally would profit by any activity he might contemplate, but how much the other fellow would profit as well. This in the future will be the essence of management.

Discrediting the Expert

The "gas expert" is falling into discredit; strangely, too, not through the actions of those to whom the term may be truthfully applied, but through the actions of some who have usurped the title as a convenient means to easy profit.

The rates and valuations proceedings of recent years have brought forth a strange brood; men whose arithmetic has a wonderful flexibility. They are witnesses for fees, so-called experts who, regardless of the end sought, can so mould their testimony as to prejudice judgment in its favor.

It would seem far fetched indeed to establish a connection between Liberty Bonds and the elimination of high-priced "experts" engaged to obtain a prejudged end. Yet there has been a growing disinclination on the part of the population of our va-

rious cities to burden down their tax rolls with this particular type of parasite. It is the new economy. People want to know where their money goes, want to know what they are going to get from it, before they spend it. Vastly more consideration is being shown the dollar. And the reason is the thrift habit inculcated by Liberty Bonds.

Like all public movements, little discrimination is being shown as to whose head is being lopped off. Real experts and those who are experts only by their own admission are beginning to encounter lean pickings. Some who were doing useful work have been ousted. In this the public suffers, but so expensive and so morally demoralizing has the "build-the-figures-to-suit-the-end-desired expert" become that the loss is more than compensated for.

The public is surfeited with "experts" and the politicians who use them. They have been found too expensive. The "experts'" losses will be the people's gain and a decided economy to utilities.

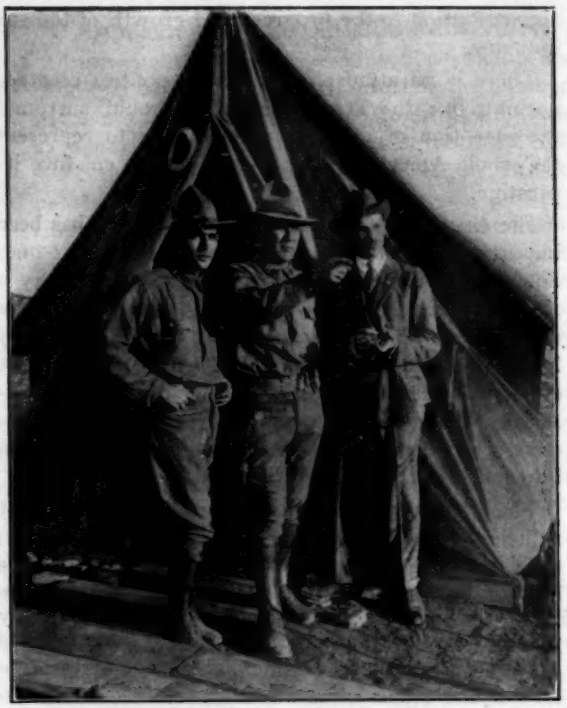
How the Gas Companies Are Helping the Nation

FRANK DEVERS, who is employed by the Beverly Gas & Electric Company, Beverly, Mass., recently left West Lynn with the draftees. Before leaving he was presented with a handsome wrist watch by employees of the company.

THE OMAHA GAS COMPANY employees have bought $10,500 worth of Liberty Bonds through the Merchants National Bank.

L. R. DUTTON, the division manager of the Jenkintown division of the Philadelphia Suburban Gas & Electric Company, supplying gas and electric service in various towns between Philadelphia and Souderton, Pa., has been granted leave of absence by the company from May 1, 1918, to engage in war welfare work in connection with the military training camps. Mr. Dutton has been appointed to a secretaryship of the Y. M. C. A. at the Base Hospital at Camp Dix, Wrightstown, N. J., and expects to start the organization of this work this week.

THE KINGS COUNTY LIGHTING COMPANY, of Brooklyn, N. Y., has thirty-five of its employees at the front helping to make the world safe for democracy. Of those who enlisted, two, James MacNaughton and Dominick Ally, have made the supreme sacrifice. Mr. MacNaughton was the first man of the company to go to the front, and he was one of the first hundred thousand which turned back the Hun drive and saved the day for the Allies. During those first days, Mr. MacNaughton, who was a member of the Gordon Highlanders, fought with unmitigated effort. He was three times wounded, but three times returned to the front ranks. He was finally mortally wounded when the Highlanders made their splendid stand and were almost completely wiped out. Mr. Ally lost his life at the battle of Cambrai, and the records show that he was mentioned in dispatches from the front for bravery displayed. A service flag with the thirty-five stars showing, together with the two that tell the story of the sacrifice, will be unfurled with fitting ceremonies by the company. Ralph Elsman, general manager of the company, has ordered that honor rolls be made and placed in the various offices of the company.

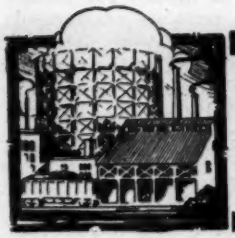


IN THE MIDDLE OF GROUP CAPT. FRED D. BAKER, QUARTERMASTER DEPT., U. S. A., FORMERLY NEW BUSINESS MANAGER, SIERRA & SAN FRANCISCO POWER COMPANY—TO RIGHT CLYDE POTTER, ADVERTISING AND PUBLICITY MAN FOR SOUTHERN COUNTIES GAS COMPANY OF SOUTHERN CALIFORNIA, WHO RECENTLY ENTERED MILITARY SERVICE

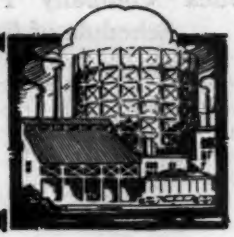
CHARLES M. SHERWOOD, since receiving his commission as first lieutenant, has been assigned as assistant artillery engineer of the Coast Defense of Long Island and is stationed at Fort H. G. Wright, Fishers Island, N. Y.

THE MIDDLE WEST UTILITIES COMPANY and THE PUBLIC SERVICE COMPANY OF NORTHERN ILLINOIS each subscribed to $100,000 worth of Liberty Bonds of the third issue.

THE COAL AND COKE UNIT in the Liberty Loan campaign last week oversubscribed its quota of $1,800,000 by $1,521,000. The heaviest subscriber in this unit was the By-Products Coke Corporation, with a total of $140,100.



NEWS OF THE GAS INDUSTRY



New Jersey Company Allowed a War Surcharge

An increase of rates because of war-times has been granted to the Consolidated Gas Company, which operates in Asbury Park, Long Branch, West Long Branch and Red Bank, by the board of public utility commissioners.

The company had asked for permission to increase its rates with the understanding that they were to be in force only during the war-times and to be suspended at any time the commission might decide.

The board allowed the adding of a war surcharge of 10 cents per 1,000 cu. ft. to the present rates for gas.

Hartford City Plant Badly Damaged by Fire

Four Hartford City Gas Light Company tanks are located within a hundred feet of the company's supply house on Front Street, which was badly damaged by fire. Somebody threw a lighted match into a large quantity of oil which had accidentally overflowed into the Park River skirting the supply house. Immediately flames began shooting high in the air and leaped through some open windows of the one-story brick structure. The escaping oil covered an area half the breadth of the river and more than 50 ft. each side of the building. The blaze in the river continued to spread, and extended under the stone bridge which spans Front Street to the other side of the thoroughfare, where a veranda on the side of the river caught.

Damage to the plant is estimated at about $1,000.

Economic Company Awarded Franchise

The Economic Gas Company was recently awarded a franchise to lay gas mains in the roads and highways of the county outside of incorporated cities by the Board of Supervisors of Los Angeles.

The franchise awarded runs for forty years, but the county reserves the right after five years to acquire the works or any portion of them upon making reasonable compensation.

The company is required to pay the county 2 per cent of its gross receipts after the first five years, and it is specifically provided that the company shall not sell, transfer, assign or lease the franchise or any part thereof without the consent of the board of supervisors.

Committee Appointed for Postponing All Unnecessary Work in Illinois

John A. Spoor and Charles H. Wacker, both of Chicago, and John H. Harrison, of Danville, Ill., have been appointed by Samuel Insul, chairman of the Illinois State Council of Defense, as a committee to investigate plans for all proposed public improvements with a view of postponing until after the war all public work that is not absolutely necessary.

Boston Output Increased Six Per Cent

The gas output of the Boston Consolidated Gas Company for April was 496,396,000 cu. ft., an increase of 6 per cent over the corresponding month a year ago. March output was 572,494,000 cu. ft.

Parkesburg Company Wins Decision for Exclusive Right to Serve Gas in Valley Township

Charles F. Cattell, general manager of the Parkesburg (Pa.) Gas Company, has received official information from the Prothonotary of the Pennsylvania Superior Court that the latter has rendered a decision dated April 22, 1918, affirming the public service commission's ruling giving the Parkesburg Gas Company the exclusive right to serve gas in Valley Township along Valley Road to Coatesville. There are 1,000 building lots sold along Valley Road, west of Coatesville, in this district, which is building up rapidly. The company is now installing services to residences along the Valley Road, Pomeroy Manor, etc. This case has been pending since October, 1916.

Increase Requested by Pocatello Company

The Pocatello (Idaho) Gas & Power Company has asked permission of the public utilities commission to increase its rates. The company asks for an increase of about 30 per cent over rates now in force.

Petition for Proposed New Ordinance of Miami Company Must be Signed by 15 Per Cent of Voters

The city council recently put it up to the Miami (Fla.) Gas Company to go out and get the signatures of 15 per cent of the voters of the city to a petition for a proposed advance in the gas rate from $1.50 to $2 per 1,000 cu. ft., for a period of five years, before the question will be submitted to the voters at a special election.

Recently the gas company secured the signatures of the required number of voters to a petition for an increase to $2.50 per 1,000 cu. ft., which was to have been submitted to the voters at a special election set for April 16, but the company, through its legal representative, Attorney W. P. Smith, requested the city council to withdraw the proceedings for the special election and asked that arrangements be made for another special election, when a $2 rate would be asked.

Utica Company Files New Schedule of Rates

The cost of production and distribution is given as the reason for the advance in the price of gas by the Utica Gas & Electric Company in Little Falls, Herkimer, Ilion and Mohawk, for which new schedule of rates has been filed by the company with the public service commission at Albany.

The same rate for the city of Utica and the other places included in the Utica district will probably follow within a short time. The Herkimer County rate is effective June 1. The Herkimer district includes the city of Little Falls and the town of Little Falls, the town of German Flatts, Herkimer, Ilion and Mohawk. The Utica district includes, besides the city of Utica, the towns of New Hartford and Whitestown and the villages of New Hartford and Whitesboro and the towns of Schuyler and Frankfort in Herkimer County.

The new rate will be as follows:

Block meter rate: First 25,000 cu. ft. per month, $1.40 per 1,000; next 25,000 cu. ft., $1.30 per 1,000; next 50,000 cu. ft., $1.20 per 1,000; next 150,000 cu. ft., $1.15 per 1,000; next 250,000 cu. ft., $1.05 per 1,000; all over 500,000 cu. ft., $1 per 1,000.

Discount from foregoing rates 10 cents per 1,000 cu. ft. for payment within discount period, which is ordinarily ten days from date of bill.

Chariton Rates Increased

The gas rates at Chariton, Iowa, have been increased 30 cents per 1,000 cu. ft., making the price $1.80 for bills paid on or before the 10th of the month and $1.95 if paid later. The minimum charge is 75 cents.

Chariton is served by the Peoples Gas & Power Company.

Increase Announced by Rockville-Willimantic Company

The Rockville-Willimantic Lighting Company, serving Rockville and Willimantic, Conn., has announced an increase in the price of gas of about 3 per cent.

This increase is made by reducing the discount which has been given to those who pay their bills promptly, so gas now sells at $1.50 a thousand feet with no discount. The new rate will go into effect on gas sold after April 30, but will not be noticed until the June bill, as the meters are read in the middle of the month.

Franchise Tax of $1,637.79 Paid by Pawtucket Company for First Quarter

The Pawtucket (R. I.) Gas Company recently sent a check to City Treasurer White for franchise tax, based on 2 per cent of earnings of the company for the quarter ending March 31, the amount of which was $1,637.79.

Citrus Belt Company Granted Increase

The railroad commission has authorized the Citrus Belt Gas Company to increase its rates beginning May 5 in the cities of San Bernardino and Colton, Cal., to provide an adequate return on the cost of the system and plant. This company serves gas to Redlands, San Bernardino, Colton and Corona. The rates for the cities of Redlands and Corona were raised last September.

Riverbend Company Authorized to Increase Rates

The railroad commission has authorized the Riverbend Gas & Water Company to increase its gas rates for gas served to consumers in Dinuba, Parlier, Reedley and Kingsburg, Fresno County, Cal., to the following schedule:

First 600 cu. ft. a meter a month, $1 net; next 2,400 cu. ft., $1.60; next 4,000 cu. ft., $1.40; next 8,000 cu. ft., $1.20; all over 15,000 cu. ft., $1 net.

Pittsfield to Pay 10 Cents More for Gas

The Pittsfield (Mass.) Coal Gas Company has announced an increase of 10 cents in the price of gas to domestic users, making it $1.20 for 1,000 cu. ft. This advance becomes effective May 1 and its operation will be felt in the June 1 bills. The company made a similar advance last September. If conditions return to normal a reduction will be made. There are 11,000 consumers, and bills will be subject to a 10 per cent discount if paid before the 10th of the month. The net price of gas in excess of 50,000 cu. ft. a month for industrial concerns remains unchanged. The abnormal conditions because of the war are given as the reasons for the latest increase. The company serves Pittsfield, Dalton, Lenox and Lee, and has 125 miles of pipe in service. The company has been authorized to issue capital stock to the amount of $204,000. Manager H. C. Crafts recently attended a conference in Washington, D. C., with reference to the coal situation, which is still acute. The company has 8,500 pre-payment "quarter meters," and these will be regulated to meet the new price.

Rate Hearing Continued to August 28

The hearing on the petition of the Public Service Company of Northern Illinois for permission to increase the wholesale rate for gas has been continued by the public utilities commission to Aug. 28.

Danbury Gas Rate Dispute Settled

A rate dispute between the city officials of Danbury, Conn., and the Danbury & Bethel Gas & Electric Company has been settled, and the complaint filed by the State council with the Connecticut Public Service Commission has been withdrawn. The city's protest was against the rates put into effect on September 1, 1917, on gas. The agreement increases the rates for gas 15 cents per 1,000 cu. ft., with a maximum charge of $1.45.

Houghton & Hancock Rates Increased

The Houghton and Hancock councils, in joint session, agreed to give the Michigan Gas & Electric Company the right to increase its rates 10 cents a thousand above its franchise maximum. This will make the rate $1.40 a thousand.

Florence Council to Vote on Increase May 14

The Florence (S. C.) Gas Company has requested the city council to grant the company an increase in gas rates. The council has called an election for May 14, at which time the council will vote on such an increase.

In Restaurant of This Type "Effects" in Illumination Have a Practical as Well as Aesthetic Value

VIEW SHOWS WHAT CAN BE DONE WITH GAS—SCHUYLER CAFE, LONG BEACH, CAL., USING NO. 2 WELSBACH REFLEX LIGHTS ON SIDE WALL BRACKETS AND NO. 1686 CENTER STEM FIXTURES FOR GENERAL ILLUMINATION—SOUTHERN COUNTIES GAS COMPANY OF CALIFORNIA SUPPLIES GAS

To Be a Good Commercial Man Is to Be Something Well Worth While

(*Continued from page* 447)

very much worth while, for commercial men continually serve and there is constant pleasure and profit derived by those who give good service.

Going After New Business in An Effort to Decrease Unit Costs by Increasing Volume of Sales

The past year has shown substantial progress in practically all gas companies throughout the country, due principally to the high cost and scarcity of other fuels. With the increased cost of labor and materials and no immediate adjustment of rates obtained to offset present conditions, instead of slacking their efforts some of the larger companies are enlarging their commercial departments and going after more new business in an endeavor to decrease their unit costs by increasing their volume of sales.

With the many changes that have taken place during the past year, the entering of more women in the field of business has been one of the big factors in lifting business life to a higher plane. Wherever women have taken up work in an organization there has been a decided improvement in the manners and appearances of men. The refining influence of women may account for the wonderful steps taken by modern business to adjust itself to the new conditions. There is no field so promising for men and women of good character and high purpose, men and women who are endeavoring to take a part in the world's work. There is no place where men and women of strength and purpose are so much needed as in the midst of commercial life. There is no school where the principles of life can be so well learned and taught.

Among the most advanced commercial organizations of to-day is one central thought in the carrying on of their business, one aim which is the only justifiable reason for their existence, "Human Service."

New Gas Schedule Filed by Malone Company

The Malone (N. Y.) Light & Power Company has filed with the Public Service Commission, Second District, a new tariff schedule to become effective on June 1 and affecting the village of Malone. The proposed change is an increase in the rate for gas from $1.50 to $1.75 per 1,000 cu. ft.

Personal Notes

R. E. Morrison, representative of the Empire Gas & Fuel Company at Kansas City, Mo., will be chairman of the information committee of the International Convention of Rotary Clubs, to be held in that city in June.

George Williams has been elected a director of the Cities Service Company, succeeding John C. Mitchell, of Denver, whose Federal Reserve Bank duties prevented attendance at many directorate meetings.

J. F. Owens, vice-president and general manager of the Oklahoma Gas & Electric Company, was elected president of the Oklahoma Gas, Electric and Street Railway Association at the annual convention in Oklahoma City, April 22-24.

Robert G. Shaw, treasurer of the Western Machinery Company, formerly the Western Gas Engine Corporation, died recently at his home, 1752 West Forty-seventh Street, Los Angeles, Cal.

L. A. White, superintendent of the Muskogee (Okla.) Gas & Electric Company, presented a paper on "Gas-Fired Boilers" at the annual convention of the Oklahoma Gas, Electric and Street Railway Association.

The American Cities Company at its annual meeting elected the following officers: F. T. Homer, president; E. G. Connette, vice-president; Lee Benoist, financial vice-president; Arthur L. Linn, Jr., secretary-treasurer; C. B. Murphy, assistant secretary and assistant treasurer; M. D. Evans, assistant secretary and assistant treasurer.

E. C. Pfenning, secretary of the City Light & Traction Company, Sedalia, Mo., has been transferred to a similar position with the Montgomery (Ala.) Light & Water Power Company. Allen O. Brannon, general bookkeeper at Sedalia, succeeds Mr. Pfenning.

William F. Dunker, secretary and treasurer of the Stacey Manufacturing Company, Elmwood Place, Ohio, who, on April 10, underwent an emergency operation for appendicitis at Christ Hospital, Cincinnati, while convalescing, is still confined to his bed at the hospital, but hopes to be back at the office and resume his duties within a few weeks.

Walter A. Fairservis has been appointed advertising manager of the Kings County Lighting Company, Brooklyn, N. Y., and has started an educational campaign for the consumers. Mr. Fairservis was formerly with James A. Donnelly, New York, and before that was connected with the Theodore Presser Company, Philadelphia, Pa.

E. G. Holzer, who for fifteen years has been the manager of the Easton (Pa.) Gas Works, will become manager of the Jenkinstown division of the Philadelphia Suburban Gas & Electric Company, and will look after the company's various activities in connection with the present heads of departments of the company in the absence of Manager L. R. Dutton.

The Welsbach Company has announced the removal of its Cleveland department from 1403 West Sixth Street to 1102-1104 Superior Avenue. The new location is better adapted to the business carried on by the Cleveland department, that is, catering to the retail trade. The sale and rental nof commercial lamps will be continued and the department conducted under the successful mangement of George W. Riley.

Construction Notes

Scranton Company Making Improvements

The Scranton (Pa.) Gas & Water Company has awarded contracts for making improvements at its gas plant on Scranton Street. The generating sets are to be remodeled, a 400-hp. boiler and a waste heating boiler are to be installed.

The installation of the latter will mean a big saving for the company in the amount of coal used. Waste gas will be used mainly in firing this boiler.

Pacific Oil & Gas Company Organized

Articles of incorporation were filed with the county auditor recently by the Pacific Oil & Gas Company. The company has a capital stock of $2,500,000, and will make headquarters in Spokane, Wash. The incorporators are G. W. McKee, F. Johnson and William S. Lewis, all of Spokane.

The company, which has properties at Rawlins and Worland, Wyo., will engage in drilling and exploring for gas and oil; producing, refining, distilling, treating and manufacturing and carrying oil, petroleum and natural gas, and will establish agencies and warehouses, as well as storage tanks, in different parts of the State.

Wilputte Corporation Awarded Contract for Forty Ovens

The Wilputte Coke Oven Corporation, of New York City, has been awarded a contract for the construction of forty Wilputte ovens, with extensions to the existing by-product plant and benzol plant, by the Citizens Gas Company of Indianapolis.

Work has been started and the plant is expected to be in operation by December, 1918.

Kansas Company Will Not Rebuild Offices Until After The War

Manager W. R. Murrow of the Kansas Gas & Electric Company, of Independence, recently announced that his company has decided not to rebuild its offices on South Sixth Street, recently destroyed by a gas explosion, until the conclusion of the war.

Installation of Additional Unit Started at Brainerd

The Brainerd (Minn.) Gas & Electric Company, of which A. G. Whitney, St. Cloud, is the head, has commenced the work of installing an additional unit in Brainerd to cost $10,000 and which will do away with any possible interruptions in service. H. S. Boyd, engineer of the gas company, recently arrived from Newton, Iowa, to superintend the work of installation. A foundation is to be built for the machinery.

No Doubt that Gas-Fired Boilers Have Greater Future To-day than Ever Before

(*Continued from page* 446)

if the same boiler is fitted with good furnaces and arranged for gas firing it will do somewhat better. In any case where gas firing is concerned the choice of the right combustion arrangement is much more important than the choice of the best boiler. Up-to-date boilers do not differ in their results when coal fired, and, when the same stokers are chosen, by more than 5 per cent at the outside; whereas, when it comes to gas firing, one combustion arrangement can easily do 50 per cent better than another.

Another important question is the arrangement of superheaters in gas-fired boilers. When gas-fired boilers are arranged for hand firing and gas firing, the nozzles of the burners are apt to be too near the superheaters, so that in a good many cases the superheat imparted to the steam is more than is wanted. A superheat of about 85 deg. C. is the highest temperature which has been in common use in reciprocating engines and in the earlier turbines. To avoid raising the steam to a higher temperature than is required it is advisable that the distance between the superheaters and the nozzles of the burners should be, if possible, more than 10 ft., so as to ensure that the superheater does not come into contact with the burning gas.

Ideal Boiler Not Yet Developed

The ideal boiler for gas firing has not yet been developed. There is no doubt that a water-tube boiler which is arranged so that the gas can be fully burned before passing through the tubes, and where the gas stream is kept at right angles to the line of the tubes by careful baffling, is the best boiler we have so far. To get higher outputs from such a boiler per square foot of heating surface is a matter calling for more rapid combustion of the gas, with more intense flame temperature, and this can easily be arranged where required.

The author has never come across a water-tube boiler with small diameter tubes, such as, for example, the Yarrow boiler, gas fired. It seems probable from the theoretical point of view that the Yarrow boiler would give excellent results. As the tubes are only about 1 in. in diameter, the proportion of heating surface touched by the gases to the wetted surface of the tubes is much larger than in the usual forms of water-tube boilers. As also the tubes are only about ½ in. apart, the waste gases must pass between them at a high velocity. For these reasons the author would expect to get a high output and economical results with this type of boiler.

Boiler Draught

The efficiency of a boiler depends for any given combustion arrangement on two factors—the gas pressure and the chimney draught. Gas pressure regulates the quantity of gas admitted to the boiler; the chimney draught regulates the air drawn in at the boiler front, and also the speed at which the products of combustion travel through the boiler. Given a gas which does not materially change in its composition, a boiler will always give uniform results, provided that the gas pressure and the chimney draught are constant. If the products of combustion travel through the boiler at a certain constant speed, the question of regulating the gas is a comparatively easy one, whereas if a boiler is joined to a stack the question of draught is more difficult. The draught obtainable from a given stack varies with the temperature of the waste gas entering the stack and with the outside temperature of the atmosphere. For this reason the author would advocate, where possible, the adoption of automatic damper control or of induced draught. With a constant draught and a constant gas pressure there should be no difficulty whatever in obtaining a constant maximum efficiency on a gas-fired boiler.

The theory is often propounded that the efficiency of a boiler increases with the velocity of the products of combustion, or, in other words, that if the products of combustion pass quickly over the heating surface of the boiler more heat is taken up from them than when they pass slowly. The author's experience leads him to the conclusion that this theory is incorrect. He has found that by increasing the velocity of the products of combustion he is in a position to increase the evaporation per square foot of heating surface, but the ratio between heat in steam and heat in gas, or, in other words, the efficiency has decreased. He thinks the reason for this is clear. Increased velocity gives greater scouring action of the gases on the boiler tubes. Few boilers, however, are so designed that all the products of combustion are compelled to come into close contact with the tubes, and this defect is exaggerated if the gases are drawn along more quickly.

Boiler Settings

The provision and upkeep of boiler settings sufficiently substantial to limit the conduction losses by insulating a boiler are equally necessary for coal and gas-fired boilers. The author proposes to go into the question rather fully from the gas-firing point of view, as it is a matter which has received far too little attention. It is preferable to have a poor boiler with a good setting than the best boiler with a bad setting.

The losses of efficiency by way of boiler settings are twofold—the loss through infiltration of false air into the boiler through the brickwork, and the loss of radiation and conduction of heat from the boiler out through the brickwork. As regards the entry of false air, all this air must be heated to the exit temperature of the gases. The actual heat thus carried away to the chimney is not the whole of the loss, as there must also be taken into account the loss in temperature of the flue gases when mixed with the false air. This lowers the ratio of the temperature of the gases to the temperature of the boiler tubes, and therefore reduces the efficiency of the heat exchange. The loss by infiltration of false air is in many cases a loss of efficiency of 15 per cent or more. By looking up the tables given later, the actual loss for different proportions of air can be directly ascertained, but it should be remembered that as more false air is present the exit temperature of the flue gases is usually higher and not lower, owing to the interference of this air with the heat exchange.

Air Leakage

The procedure in order to discover air leakages in boiler settings is very simple. If we assume a boiler using blast-furnace gas, and find that when this gas is burnt with an excess of air of 25 per cent, 1.785 cu. ft.

dry waste gas contains 0.37 cu. ft. of CO_2, or that the CO_2 referred to the dry waste gas is 20.7 per cent, and if a sample of the waste gas taken at a distance of 15 ft. from the burner nozzles, or in the case of Lancashire boilers at the end of the first flue, yields this percentage of CO_2, the same proportion of CO_2 should prevail throughout the boiler, provided that there are no air leakages. Should there be a decrease in CO_2 it would prove the presence of air leakages, and by taking tests varying distances from the burner nozzles the places where air leakages occur can be exactly ascertained.

As soon as these air leakages have been found they must be stopped. The first thing to be done in such a case would be to clean the outer side of the brickwork settings thoroughly, remove all loose mortar and repoint the brickwork. This will, as a rule, greatly improve matters, but brickwork settings have generally a very large number of small crevices which are hardly visible to the eye. These crevices admit a great deal of false air, as the analysis of the waste gases shows. In order to close these it is necessary to cover the brickwork settings with several coats of thick tar, which should be renewed from time to time until the whole of the brickwork is covered with ¼ in. layer of tar. The tar will fill up all crevices and will provide nearly air-tight boiler settings.

If one is set the task of getting the best out of a boiler which is known to have a very leaky setting, the procedure is as follows: Assuming the boiler to be provided with burners, and with sufficient gas or air pressure to force the gas and air through the burners, the damper is lowered until the flow of the products of combustion is checked, and the boiler is then run practically with no draught at all, or in a state of balanced draught. Of course this is liable to cause flames to come out at the air inlets round the burners, and care must be taken to keep sufficient draught to prevent this. The author knows of one case where this method was used on a water-tube boiler with a very leaky setting, and good results were got on the test which was carried out.

Radiation and Conduction

The losses through radiation and conduction of heat from a boiler are not sufficiently realized. When we consider that there are boilers which lose 1½ per cent from these causes, and others which lose 15 per cent, it is evident that matters require attention. Owing to the difficulties of accurately measuring large volumes of gas in the state in which it is used for boiler firing, it is practically impossible to measure directly the radiation loss while gas firing a boiler. The usual practice is to test this loss when coal firing the boiler, and to assume that the loss is the same while gas firing. The results of a large number of tests of well-protected boilers which were published some time ago, showed that in no case was the radiation loss over 2½ per cent.

One very common mistake, for which one has to pay very dearly, is to have boilers in the open air and not in a boiler house. As the radiation losses are dependent on the temperature inside the brickwork, the thickness of the brickwork, the temperature on the outside of the brick, and the wind velocity, it goes without saying that the radiation losses in the winter months with rain and high winds must be very much larger than in the case of summer heat. The radiation loss may be greatly reduced by building houses around boiler batteries. To reduce this loss to figures, a 30 x 8-ft. Lancashire boiler working continuously on gas raises steam worth over $10,000 per annum at present. It is possible in almost every case to save 5 per cent in the radiation loss by putting a house round a boiler. Five hundred dollars a year saved per boiler makes the cost of the house seem a foolish economy.

Another mistake which is very frequently made is parsimony when erecting the brickwork. The brickwork is often not thick enough. This is not a mistake confined to boilers, but occurs equally in gas producers and metallurgical furnaces. It is no economy to build light boiler settings, as the additional cost of heavier walls, etc., will very soon be repaid on the savings in radiation. For a Lancashire boiler in the open air, the radiation loss from the exposed front is about 1 per cent, showing a loss of $100 per annum, a sum which would pay many times for the cost of a suitable covering.

As a rule, modern water-tube boilers have suitably thick brickwork settings. In one installation of gas-fired Stirling boilers, and in a boiler house, the insulation is so good that in winter the boiler men asked for a stove in the boiler house on account of the cold.

In cases where it is not convenient or practicable to determine the losses of a boiler through radiation and conduction of heat by means of careful test of the boiler with coal firing, these loses may be roughly estimated at the following figures:

	In Boiler House	In Open Air
Water-tube boiler..	1½ to 3 per cent	6 to 8 per cent
Lancashire boiler...	5 per cent	10 to 12 per cent

These figures can be used only for rough calculations, as to depend on them would in some cases lead to serious mistakes.

Combustion

Combustion is the name given to the chemical reaction between elements or compounds and oxygen which takes place at what is called the ignition temperature, a temperature varying for each element or compound. Before the reaction can take place, the fuel must have reached its ignition temperature, which is usually attained by adding some external heat; for instance, burning wood, coal or the like. The heat evolved by the reaction must be great enough to raise the temperature of the products of combustion to at least the ignition temperature. If the heat evolved is insufficient for this purpose, then the reaction cannot continue by itself and will cease at once when no more outside heat is added.

Let us consider the combustion of hydrogen in pure oxygen. The equation for this reaction is: $2H + O = H_2O$, or in molecular weight $2 + 16 = 18$. The molecular heat of formation, taking water as uncondensed, is 58,000 calories; in other words, if 2 kg. of hydrogen are combined with 16 kg. of oxygen, they form 18 kg. of water vapor and evolve a heat of 58,000 calories. These 58,000 calories must be sufficient to raise the temperature of 18 kg. of aqueous vapor above the ignition temperature of hydrogen, which is 600 deg. C. As 18 kg. aqueous vapor correspond to 22.22 cu. m., we can apply the Le Chatelier formula in the following manner:

$$22.22 \times (0.34t + 0.00015t^2) = 58{,}000,$$

or $$t = 3{,}191 \text{ deg. C.}$$

The heat evolved is therefore sufficient to raise the temperature of the products of combustion by 3,191 deg. C., and as the ignition point is as low as 600 deg. C. it is shown clearly that the reaction in this case continues once the ignition point is reached.

As an example of a case where the reaction cannot continue, owing to the fact that the heat evolved is not sufficient to heat the products of combustion up to ignition point, let us take the case of a gas containing 10 per cent of CO, 20 per cent of CO_2, 70 per cent of N_2. The calorific value of such a gas would be only 34 B.t.u., or 306 calories. Let us assume that this gas is burnt in air with an excess of air of 50 per cent. This gas would theoretically require 20 per cent of air for combustion, and if 50 per cent excess of air is present, then each cubic meter of gas would give 0.30 cu. m. of products of combustion, of which 1.31 cu. m. is CO_2 and the balance oxygen and nitrogen. We apply the Le Chatelier formula as follows:

$$(1.01) \times (0.303t + 0.000027t^2) + (0.30) \times (0.037t + 0.00022t^2) = 306, \text{ or } t = 432 \text{ deg.}$$

or, in other words, the heat evolved is sufficient to increase the temperature of the products of combustion by 432 deg. C.

As the ignition temperature of carbon monoxide is over 600 deg. C, it is evident that such a mixture could not burn unless sufficient heat were constantly admitted to keep the products of combustion at the ignition temperature.

In a boiler the flames play on the boiler flues which are cooled by the water, so that the heat evolved by the combustion of the gas must make up for the cooling effect of the boiler plates. It follows that while theoretically a gas containing as only combustible 20 per cent of CO would be able to burn if not being cooled, in practice such a gas would be extinguished under a boiler.

For the scientific study of the combustion of gas, we must first have the analysis of the gas to be used. From the analysis we can calculate the calorific value as shown above, the combustion temperature, and the analysis of the products of combustion.

If we wish to check the combustion by means of a pyrometer, it is, of course, first necessary to know at what temperature the best conditions for combustion are obtained in practice. In other words, we must calculate the theoretical combustion temperature, and this varies for each change in the amount of excess air present. As regards the maximum excess of air allowable, it may be taken, as a general rule, that total combustion with an excess of air of 20 per cent is as favorable a result as should be expected.

A good combustion arrangement will give complete combustion with an excess of air of 10 per cent, but with the usual industrial gases there are such large fluctuations in the composition and calorific value that we do not usually dare to reduce the excess of air for continuous working under 20 per cent on account of the danger of having unburned gas in the waste gases.

All this information is, however, of little use unless we have the power to remedy conditions. First of all, it is essential that a proper combustion arrangement should be provided. Until this is done, little progress can be made. Good combustion can only be attained by providing an intimate mixture of air and gas. Complete combustion should take place very rapidly at the highest possible temperature and with the smallest possible excess of air.

At different plants we find not only gases with different analysis, different temperatures and different pressures, but the conditions also vary as to type of boiler draught and load. Each case has to be considered in all its details. It is not always safe to say that a certain combustion arrangement will suit because it is working successfully in another plant under somewhat similar conditions.

The original method of burning gas in boilers was simply to pass the gas into the flue from an opening near the door and to admit air by the door. The air and gas were left to mix as best they might. There are still far more boilers in this country fitted with this arrangement than with all other arrangements put together. The usual improvement upon this method is the provision of combustion chambers in front of the boilers. Combustion chambers lose a serious amount of heat by radiation, and give the maximum temperature in the wrong place—outside the boiler instead of inside. Neither of these methods is of any use when the larger boiler outputs are required, as unburned gas appears in the waste gases as soon as the boiler load is forced. The usual efficiency of boilers fitted with these arrangements is about 55 per cent. Sometimes it is as high as 60 per cent, and often it is far below 50 per cent.

Combustion arrangements have to be designed to suit three different conditions of gas pressure.

(1) Steady pressure of 1-in. water gauge or more.

(2) Intermittent pressure, ranging constantly from 1-in. water gauge or more to nil, with total stoppage of the gas flow and extinction of the flame.

(3) Very low gas pressure, or a pressure which may sometimes be high, but is low for considerable periods.

(1) For a steady gas pressure the Bunsen type of burner gives the best results. Such burners would have been generally adopted years ago, but for the technical difficulties in designing them. It is easy to design the small Bunsen burner we use in the laboratory, but much more difficult to design burners for 80,000 to 120,000 cu. ft. of gas per hour.

A good burner of this type provides its own primary air, which amounts to 60 per cent of the air necessary for combustion. The gas, acting as an injector, draws in this air and also mixes thoroughly the air and gas before ignition takes place. Whether or not the burner is doing its duty in this respect can be tested by taking a CO_2 reading of the gas-air mixture in the burner barrel. The secondary air, which is just as essential, is drawn in by the chimney draught, in conjunction with the injector action of the mixture emerging from the burner nozzle.

The maximum flame temperature should be found in the region of the boiler within a few feet of the burner, and there should be a minimum volume of flue gases carrying away heat to the chimney. The amount of gas to be burned in a boiler is only limited by the volume of gases with which the flues can deal under the conditions of gas pressure and chimney draught. Thus the boiler output is larger than it could possibly be with a bad combustion arrangement, in addition to the efficiency being improved.

(2) Intermittent gas pressure is found at most iron works having no gas-cleaning plant. Each time a bell is lowered to admit the charge into a blast furnace, the

gas pressure drops and usually the gas fails altogether. Ordinary Bunsen-type burners are useless under these conditions. They light back at the gas inlet inside the mixing tube and each burner requires attention from the boiler man every time the pressure falls—say every ten minutes—an impossible proposition. It is only very recently that this problem has been solved. Burners have been developed which draw in and mix primary air with the gas in a similar manner to the Bunsen burner. These burners work on the injector principle. Their mixing tubes are made conical, expanding in cross-section from the gas inlet to the burner nozzle. This form offers practically no frictional resistance to the flow of the mixture of gas and air. It is well known that a flame travels through a mixture of air and gas at a certain definite speed for a known mixture. The burners are so proportioned that the speed of the mixture of air and gas at the burner nozzle is greater than the speed of the explosive reaction of the flame, and, therefore, when the gas pressure is present the gas burns at the end of the burner. When the gas pressure falls the gas burns at that point where the speed of the gas-air mixture corresponds to the speed of the flame. When the gas falls, the flame is extinguished and a small coal fire is kept in the boiler to ignite the gas when it returns. As soon as gas pressure returns, the velocity of the gas-air mixture forces the flame out of the mixing tube and combustion continues at the burner nozzle as before.

It is found that this burner automatically adjusts, over considerable variations of gas pressure, the weight of primary air drawn in to the weight of gas passing on account of the absence of friction in the mixing tubes. At one English iron works, on a Lancashire boiler working at a gas pressure of about 1 in. water gauge, it is found that the temperature of the waste gases is 315 deg. C., while the temperature in neighboring boilers fitted with the old combustion arrangement is from 700 to 900 deg. C., with combustion still taking place at the dampers.

(3) To deal with gas at a very low gas pressure, and to get a good mixture of gas and air, is impossible without mechanical assistance. No burner will mix them properly. A Bunsen-type burner would light back at once at such low gas pressures. The problem can be solved in two ways: (a) Air and gas can be drawn in by means of a fan, mixed completely in the fan, and the mixture supplied to the boiler by a simple pipe, or (b) power to work a Bunsen-type burner can be got by raising either the gas or the air to a sufficient pressure. The method of complete mixing is being tried in America, but the author has so far no figures for it. He has no doubt that it can be done successfully, but it is evident that it has certain risks.

If the pressure of either gas or air is raised to 2 in. or more, the conditions are then similar to those in (1), where a steady gas pressure exists. The mixing in the burner is done by either the gas or by the primary air entering under pressure, and the secondary air is drawn in at the burner nozzle as usual. To raise the gas pressure, a fan is inserted in a by-pass on the gas main, and three valves are provided to cut off the fan on each side and to close the gas main when the by-pass is open. The fan to raise the air pressure has only to deal with 60 per cent of the air required, but an air main is required connected to each burner. Although both these methods are costly, the results both as to additional boiler load and as to improved efficiency are so satisfactory as to pay many times over for the outlay.

When a short, intense flame is required, we must use either air or gas under considerable pressure. This method is well known in the case of gas furnaces for reheating and melting. From 1½ to 2 lb. per square inch pressure on the air supply is the most suitable pressure, though excellent results are got with 12-in. (water gauge) pressure. The whole of the air needed for combustion is supplied by the mixing arrangement, no secondary air being used. The author believes that by this method, which puts the boiler under pressure, and by simply drawing off the products of combustion by the chimney draught, we should make a considerable advance in the direction of a larger boiler output combined with high efficiency.

On the point as to the necessity for intimately mixing air and gas before combustion starts, it has been found in America by a series of experiments on water-tube boilers that a smaller combustion space is needed in proportion as the air and gas are more intimately mixed in the burners.

Preheated air and hot gas are of great advantage for boiler firing. Air preheated to 190 deg. C. was used at one plant with producer gas of 150 B.t.u. The sensible heat of the air added 5 per cent to the calorific value of the gas, and thus raised the flame temperature. It depends upon where the heat is got whether it really adds anything to the total efficiency. There is one arrangement in which air is preheated by coming through the center of the flue of a Lancashire boiler in an iron pipe from the back of the boiler. The air is supplied very hot, but the heat is got by taking from the products of combustion heat which should have gone into the steam. In another arrangement, gas is supplied through a pipe which passes into the boiler flue and bends back again, so that this bend is actually in the flame. The gas is heated very considerably, but again at the expense of the temperature of the products of combustion. These arrangements probably do account for some small gain in efficiency over the old methods of gas firing, but if the air or gas is heated by waste gas, say in an economizer or in passages outside the walls of the boiler, the heat then supplied is all clear gain.

There are certain cases in which a good combustion arrangement seems to fail. The peculiarities of a boiler may baffle all attempts at improvement. These are the cases which require hours of study and the use of every means which experience suggests. The solution is often found in bad design of flues, or in the defective condition of internal flue walls of baffles, and sometimes in a peculiarity of gas conditions—the conditions being different from those existing when the combustion arrangement was designed.

Gas Measurement

If the evaporation of a boiler is known, the only other thing required is to know the quantity of gas consumed. Here a serious difficulty arises. Wherever a large quantity of gas is concerned, gas measurements are difficult, and where the gas is of high and varying temperatures, and carries a large quantity of dust, they are next to impossible. Where smaller quantities of gas are concerned, as, for instance, in the case of coke-oven plants, a meter of the rotary type may be installed to obtain a constant record of the distribution of the gas over the

whole plant. In the case of producer gas and blast-furnace gas, where often millions of cubic feet of gas per hour have to be measured, a meter of the rotary type is out of the question, owing to the cost and to difficulties arising from the tar and dust in the gases. In that case velocity measurements, with the assistance of the Pitot tube or throttling disc, or anemometer, can be taken. Velocity readings taken thus cannot be trusted to give absolute readings, but they are very effective in giving readings which are relatively correct from day to day. To obtain the actual values there is no other way but to resort to theoretical calculation and to draw up a balance sheet for the carbon. By the use of a gasometer, of course, really reliable gas measurements can be made, but in most cases a gas meter is not available.

Certain points require to be watched when using gas meters unless the gas is quite free from dust and tar. A meter of the rotary type should be calibrated by means of a gasometer, both before and after use, with the actual gas it is measuring. If this is not done, large errors may arise. In one case lately, during a four days' test, the tar in the by-product producer gas partly choked up the holes in the guide plate of the rotary meter and the readings were useless, getting gradually higher as the velocity of the gas increased, until the plate became altogether choked. With Pitot tube meters, the Pitot tube must be kept clean, and should be examined and blown out at short intervals. Meters working by the difference of pressure on the two sides of a throttling disc in the gas main are, the author thinks, less apt to deceive than Pitot tube meters, because they are not so liable to be affected by eddies in the gas flow. Velocity readings should never be used unless the pipe in which they are taken is straight for about 10 diameters' length on each side of the point of reading.

The author has used both Pitot tube and throttling disc gas meters at several different plants, and on the whole has had reason to be satisfied with the readings they gave of relative volumes. He does not know of any English make of meter working on these conditions. Before the war he did his best to get one of the large English makers to manufacture these meters, and gave him all information, even offering to lend him a meter which he had found to be of the best German make, but without success. If a meter of this type is to be bought, care should be taken to see that the readings of the float are transmitted directly, without any levers of magnification, to the chart. The difference of pressure which is being measured is so small that one cannot afford to allow the possibility of any such errors in the instrument.

Boiler Control

We have got to accept the fact that the human element in almost every case is an important factor in boiler control. Of course, an arrangement can be provided whereby the air supplied to a boiler is controlled completely by the quantity of gas passing, and where the chimney draught is kept constant, either by induced draught or by damper control. Still we recognize that the cost and the added complication of such arrangements are such that few managers will install them, even though perfect combustion conditions would always prevail.

There are three methods by which we can test what results are being got by a boiler, namely, (1) by measuring the gas supplied and the water evaporated; (2) by analyzing and taking the temperature of the waste gases, as described above, and (3) by taking the combustion temperature. All these methods are good. The chemical method is slower and more laborious than the pyrometer method, but it is cheaper and gives much more information.

For testing the combustion temperature a pyrometer junction is inserted in each boiler flue within a short distance of the nozzle of the burner. All these junctions can be wired to one dial, with switches to connect each junction in turn to the dial. Such an arrangement is especially desirable if the engineer in charge has no time to be constantly at the boiler plant. He can have the dial in his office and can at any moment read the temperature in front of each burner nozzle, and give instruction to the boiler man to attend to such burners as are not working satisfactorily.

A CO_2 recorder on the boiler flue is an excellent check on the results. It will be realized, however, that very deceptive deductions may be made from the readings of this instrument. Although the CO_2 reading is good, there may be unburned CO present, causing serious losses. If an instrument were fitted to record CO_2 and CO simultaneously, it would be the ideal arrangement for the chemical control of gas-fired boilers, and the author sees no reason why such an instrument should not be made and sold at a reasonable price.

It is wonderful to see how an untrained man who has long experience of gas firing, and is interested in his work, can set his boiler to get very nearly as good results as would be got by chemical control. Unfortunately we more often have to do with the boiler man who thinks that gas burns itself, and who cares nothing about the color of the flame. It is only fair to say that hardly any works give their men any inducement to economical firing, either by bonus payments or even by providing the men with any kind of apparatus to assist them. There is no doubt that a gas-pressure gauge should be fitted, if not at each boiler at least at every range, and that it should be in a place easily seen by the boiler man. In addition to this, a differential draught gauge should be fitted to each boiler, showing the difference in draught between the front and back of the boiler, and a plain mark should be made on the dial at the reading which the boiler man is to maintain by means of his dampers. With these gauges it is an easy matter to instruct a boiler man how to control his burners without trusting alone to the appearance of the flame, even under varying conditons of gas pressure and chimney draught. On large boilers working at steady gas pressure it pays well to install automatic damper control to maintain a uniform chimney draught.

Water meters are a necessity for careful boiler control. In some Continental works a separate meter is fixed to each boiler, but at least one meter to every range of boilers is necessary. Gas meters should also be installed.

In all large works a man should be appointed to take general charge of the steam output. He need have no great chemical or engineering training, as his business is simply to run his boilers at their maximum efficiency, and all engineering matters would be reserved for the engineer or manager. At a works raising 100,000 lb. of steam per hour the value of the steam is about $200,000 per annum. If the man in charge of the boilers, by his effective control, improves the efficiency by only 5 per cent, the $10,000 saved will pay his salary many times over. In addition, there is the advantage that the

maximum possible supply of steam will always be secured.

Even with the best combustion arrangements, the result of intelligent control will be a saving of at least 5 per cent as compared with the results to be attained with the same installation run simply by boiler men, so that there is no possible excuse for a company that neglects to appoint such a man. In large American works the steam engineer is a recognized necessity, and he is a highly paid official.

The apparatus for boiler control will cost a considerable amount, and it must not be overlooked that the best outfit of recording instruments is useless unless a constant and intelligent use of them is absolutely enforced. All the temperatures, pressures, volumes and analyses taken should be entered up in a special book. At least once a week a balance sheet should be drawn up, showing the allocation of the gas to each part of the work and the results obtained therefrom. This should be submitted to the manager weekly, with the necessary explanation in case any result falls short of the required efficiency. If, in addition to this, the boiler men and the man in charge of the boiler plant are given a premium for maintaining good results, boiler control will soon develop into a fine art and prove an important source of revenue.

Women's Latest Field—In the Retort-House

Every page that is written in the history of the work of women during the war seems more wonderful than the last. Whether it is shell making, areoplane construction, building ships, motor lorries or railway wagons, making steam engines or guns, one is impressed alike by their enterprise, their industry, and their indomitable courage. And now another page in this history needs to be written—one dealing with women at work in gas works.

While women were conquering in other fields, the retort house, it was thought, needed endurance and energy beyond their powers. Women essayed the task—as they have essayed all tasks open to them—and they have proved, in a certain London gas works, that not only can they do most of the jobs well, but that in those where a meticulous carefulness is an advantage, they can beat the men. On the Rateau fan-blowers worked by two-cylinder internal combustion engines, there has been no instance of heated bearings since the women took charge (although formerly such instances were frequent); the amount of coke recovered from the furnace clinker has increased; coke sales have risen since a woman was put in charge of the weighing room, and so impressed is the engineer that he has trained a woman as his own deputy.

The women stokers say that their health has improved since they undertook the work, so enthusiastic are they. Three of four retort houses are worked solely by women. The work includes breaking the coal in the hopper above the charging machine, opening and closing the retort lids, augering the pipes with augers mounted on long ¾-in steel rods, scraping the lids of open retorts, scurfing the inside of mouthpieces, feeding hot coke as pushed from the retort into the furnaces, pushing down and leveling the charge, and lifting and closing the furnace covers.

In the purifying departments the women, with the help of two men, empty a purifier in six hours. The oxide is handled in basket skips by rods and poles, and on the revivifying floors it is wheeled in large barrows weighing 3 cwt. when loaded.

In the smith's shop, two women are blacksmith's strikers, and another operates a power hammer. In the engine room there are shift engineers, and one woman is in charge of an 80 hp. horizontal engine on the belt drive of the works' pumps. In the yard they carry ¾ cwt. bags of coke. They riddle, screen, wheel and load lorries with 1 cwt. bags, drive horse lorries and deliver the coke on customers' premises. All painting and tarring is done by them, including the gas holders and holder guide framing.

Slight alterations in the mechanical appliances have been made, in order to make the work easier. The barrow wheel has been placed further under the load, the augering tools are rather lighter, the risk of gassing is reduced to a minimum by making the box about to be emptied the outlet box for twenty-four hours before the change, and in the engine room the centrifugal governor is guarded by means of a metal shield in the form of an inverted cone.

The women are over eighteen years of age, and of average physique. Many of them used to be laundry girls. The work expected from them is two-thirds that done by a man. On day work, they draw pay and bonus in that ratio, and on piecework they receive the same rates as the men. In the retort house an extra woman is included in each shift, so that each worker may have a rest apart from the rest between each draw. They are clad in tunic, trousers and cap, but the women stokers prefer a woollen jersey. A woman superintendent has oversight of the whole of the women, assisted by a forewoman on each job.

The women's spirits are excellent. They remain at work during air raids, merely replacing their caps by steel helmets. One can add nothing further, in the way of tribute, to that—*Gas Journal* (*British*).

Gradual Development of the Coking Industry

The coking industry has not sprung into being suddenly, as a result of some striking discovery in the way that the aniline dye industry did; it has grown from the most primitive beginning. Starting with the charcoal burner and the old Meiler heap, we may trace its upward course to the beehive oven and thence to the first crude attempts at recovering the by-products from these. Up to this stage the labor required was of the lowest type. In the beehive oven as at present worked no highly skilled labor is required. Nor was any greater skill required in working the earliest retort ovens, which did not recover by-products.

It was not until the recovery of by-products from retort ovens commenced that need of skilled supervision arose.—*Gas World*.

Swedish Dyestuff Industry

Among the countries making a pronounced effort to attain material freedom from dependence upon the German dyestuff industry, Sweden is now to be enrolled. The consumption of synthetic colors is not very large, about 900 short tons annually. It is felt, however, that it is sufficient to warrant the establishment of a domestic industry, and a company has already been organized to finance the project.

Sweden lacks the raw material, as the country has no coking coal. It is, however, richer in chemicals than Switzerland.

PATENTS PERTINENT TO GAS INDUSTRY

Oven Burners May be Separately Lighted

Patent No. 1,224,157; described in Patent Office *Gazette*, May 1, 1917, page 14. John A. Fry, Detroit, Mich., assignor to Detroit Stove Works, Detroit, Mich., a Corporation of Michigan. Filed Aug. 31, 1916. Serial No. 117,851. (Cl. 158-105.)

This set of oven burners consists of two parallel burners with a connection extending between them. This latter is connected with only one of the burners, while a lighter extends from the other burner.

Box Car Loading Apparatus Consists of Several Sections

Patent No. 1,226,553; described in Patent Office *Gazette*, May 15, 1917, page 797. George Mamerre. Milwaukee, Wis. Filed Oct. 21, 1914. Serial No. 867,792. (Cl. 193-39.)

Attached to the main chute extension are tracks on which an additional counterbalanced chute extension may operate, this latter being designed to extend through the door of the box car. Also attached to the main chute structure is an extension, designed to swing into the box car to distribute the coke inside of the car.

Gas Stove Provided with Baffle Plates

Patent No. 1,228,579; described in Patent Office *Gazette*, June 5, 1917, page 70. Simon N. Mentel, Mary A. Mentel. and George E. Mentel, Springfield, Ohio. Filed June 8, 1916. Serial No. 102,462. (Cl. 126-87.)

In this gas stove a main casing is provided, which contains the burner, a baffle wall being likewise installed in the casing. A U-shaped plate embraces the lower end of this baffle wall, but is spaced therefrom, this baffle wall also being provided with passageways about the upper edge and to the rear. These communicate with the passageways formed by the U-shaped plate, such passageways extending to a point in close proximity to the burner.

Heater Equipped to Burn Gas

Patent No. 1,226,868; described in Patent Office *Gazette*, May 22. 1917, page 1073. Harry S. Dodd, Toronto, Ontario, Canada. Filed May 19, 1916. Serial No. 98,689. (Cl. 122-131.)

This gas heater consists of a tubular closed combustion chamber, with the gas burner in one end of the chamber. At the other end of this chamber is a closed expansion chamber of greater cross-sectional area than the combustion chamber. A number of fire tubes are connected to the expansion chamber and parallel to the combustion chamber. These tubes are joined to a header to which an exhaust flue is connected, an air pump being in turn connected to this flue.

Attachment on Meters Insures Them Being Set Level

Patent No. 1,228,467; described in Patent Office *Gazette*. June 5, 1917, page 32. Henry C. Morris, Dallas, Tex. Filed June 28, 1916. Serial No. 106,314. (Cl. 73-1.)

This attachment consists of a valve which is installed on the meter inlet, a crank arm normally supporting the valve off of its seat. A weight is attached to the crank as a support, the bottom of the weight resting on the meter table when the floor is maintained in a horizontal position. When the meter is tilted the weight moves the crank, which in turn closes the valve.

Patent Granted for Flash Pilot Lighter

Patent No. 1,227,078; described in Patent Office *Gazette*, May 22 1917 page 1146. Arnold O. Rutz, Milwaukee, Wis. Filed March 3, 1915. Serial No. 11,931. (Cl. 137-4.)

This lighter consists of a body provided with a uniformly cylindrical well bore, which is also provided with ports communicating with the well bore at points spaced longitudinally of the bore. A valve sleeve fastens into the bore and terminates short of the inner port, being provided with an annular recess which registers with the other port. The sleeve is reduced in bore outwardly from the ports, and a valve stem moves through the reduced bore portion, a head on the stem coaching with the inner end portion of the sleeve.

Heater Designed to be Placed Over Open Flame Gas Jet

Patent No. 1,226,964; described in Patent Office *Gazette*, May 22, 1917, page 1106. William C. Fischer, New York, N. Y., assignor to The Compound Heater Mfg. Company, Inc., a Corporation of New York. Filed Jan. 19, 1916. Serial No. 72,902. (Cl. 126-248.)

This heater consists of a perforated heat radiating chamber, with a fan suspended in the chamber. This fan is rotated by the warm air currents arising from the burner, this section forcing the heated air through the perforations. The shape of the shell tends to draw in the heated currents and direct them to the fan.

Mantle Holder Provided with Clamping Ring

Patent No. 1,227,260; described in Patent Office *Gazette*. May 22, 1917, page 1207. John G. Gotty, Jacksonville, Fla., assignor to Gotty Gas Lighting Company, a Corporation of Florida. Filed Aug. 29, 1916. Serial No. 117,481. (Cl. 67-103.)

The supporting annulus of the mantle is externally grooved, and with its edge overlapping the mantle. A ring with a tongue and slot formed upon opposite ends is placed around the annulus, the tongue engaging the slot in order to adjustably clamp the mantle to the annulus. The ring is bent laterally to conform to the contour of the outer surface of the annulus.

Need of Utility Firms Pointed Out to Wisconsin Railroad Commission

President Wilson's appeal to State and local authorities to preserve the solvency and the war service efficiency of the public utility companies of the country, by granting them rate

increases commensurate with their increased war-time operating costs, was formally presented to the Wisconsin Railroad Commission recently by a committee of Wisconsin public utility men, representing and speaking for the four national associations of public utility companies.

The speakers were S. B. Way, of the Milwaukee company, representing the American Electric Railway Association; B. F. Lyons, of the Beloit Water, Gas & Electric Company, representing the National Electric Light Association, and Sheldon J. Glass, of the Milwaukee Gas Light Company, representing the American Gas Institute and the National Commercial Gas Association.

Chairman Jackson, of the commission responded, stating that the commission fully appreciates the emergency.

The consensus of opinion of the speakers was:

"Something more than the mere preservation of the utilities is at stake. Prompt and successful mobilization of men, money and materials, essential to the winning of the war, is predicated upon a continuous and constantly extending provision of light, heat, power and urban and interurban transit facilities in every section of the country.

"Services which under ordinary circumstances were a local convenience, have under present circumstances become a national necessity. If public utility companies throughout the country were for any reason to be shut down, the whole war program would collapse instantly. It follows that insofar as the efficiency of public utilities is impaired by want of earnings needed to keep them efficient, the war program is proportionately delayed and interfered with.

"While new construction and extensions will necessarily be held down during the war, it is impossible to arbitrarily refuse to make any extensions. No extensions, however, can be made unless the utility's credit is preserved. Many utilities are facing refunding of old issues of securities and unless they can show a reasonable margin of earnings over operating expenses and bond interest, such refunding cannot be done except at ruinous rates.

"Many utility dividends have been suspended. In some cases even bond interest is in danger and receiverships imminent. Public utility credit is gravely affected and soon will be permanently impaired unless more revenue can be very generally secured.

"Public utility fuel costs have increased within two years from 90 to 150 per cent; materials used, from 35 to 300 per cent; labor, from 40 to 50 per cent. Most of the utilities are still being required by rate authorities to meet these enormous increases in operating costs with rates and fares fixed two or more years ago to yield no more than a fair return on costs then prevailing."

THE OKLAHOMA GAS & ELECTRIC COMPANY has declared the regular quarterly dividend of 1¾ per cent on the preferred stock, payable March 15 to stockholders of record Feb. 28.

PRAIRIE OIL & GAS COMPANY for the year ended Dec. 31 last indicates earnings of $56 a share on its $18,000,000 capital stock, compared with $88 the preceding year.

THE ST. LOUIS COUNTY GAS COMPANY recently issued the following report for March, 1918:

CONDENSED INCOME ACCOUNT—MARCH 31, 1918

	March 31, 1918	% + or —	March 31, 1917	3 Months Ending March 31, 1918	% + or —	3 Months Ending March 31, 1917
Operating revenues	$27,918.33	27.4	$21,913.29	$87,424.13	24.8	$70,013.54
Oper. expenses (total)	26,624.42	36.6	19,380.06	80,416.55	36.5	58,944.25
Ordinary oper. expenses	23,747.36	25.5	18,918.49	71,682.09	27.2	56,326.78
Maint. and depreciation (reserve credit)	2,179.11	2536.0	86.26	6,548.87	655.1	867.14
Taxes	697.95	27.4	547.83	2,185.59	24.8	1,750.33
Net operating revenues	1,293.91	48.9	2,533.23	7,007.58	36.4	11,069.29
Non-operating revenues	616.30	3.3	596.23	1,574.57	15.2	1,856.21
Gross income	1,910.21	39.2	3,129.46	8,582.15	33.6	12,925.50
Interest charges	3,861.30	12.9	3,420.88	11,300.93	10.4	10,237.85
Miscellaneous charges	327.54	5.4	310.67	978.83	4.8	933.85
Net income	2,278.63	278.4	602.09	3,697.61	310.8	1,753.80
% per annum earned on common stock	3.90	181.6	1.03	2.11		1.01

CONDENSED BALANCE SHEET—MARCH 31, 1918

ASSETS		LIABILITIES	
Property and plant, general account	$1,500,912.69	Capital stock—common	$700,000.00
Capital expenditures, current fiscal year	1,754.65	Funded debt	995,000.00
Treasury bonds	271,600.00	Accounts payable	170,995.64
Sundry investments	25,062.62	Matured interest unpaid	7.50
Reserve, sinking and special fund assets	17.50	Deposits	3,581.75
Cash	39,094.26	Sundry current liabilities	264.31
Notes and bills receivable	115.00	Taxes accrued	7,994.20
Accounts receivable	35,265.07	Interest accrued	17,980.51
Material and supplies	69,631.98	Sundry accrued liabilities	438.15
Sundry, current assets	2,060.83	Open accounts and deferred payments on bonds	15,510.42
Prepaid accounts	1,323.06	Reserve, sinking and special funds	130,954.86
Open accounts	234.83	Income account, current fiscal year—surplus	3,697.61
Bond disc. and expense	129,758.06	Profit and loss—profit	37,800.82
	$2,076,830.55		$2,076,830.55

Hearing on Rate Increase to be Held at Madison May 16

The petition of the Wisconsin Public Service Company for permission to increase its gas rates in Green Bay and vicinity will be heard by the railroad commission of Wisconsin on Thursday, May 16 at Madison. The petition proposes an increase of from 20 to 25 cents per 1,000 ft., according to the amount of consumption.

Rate Increase Re-suspended Until Nov. 5 in Several Illinois Cities

The Public Utilities Commission of Illinois last week resuspended until Nov. 5, 1918, the increase in rates for gas service in Moline, East Moline, Rock Island and Sylvis, Ill., asked for by the Peoples Power Company of Illinois. The company asked for permission to increase the charge for gas service to a flat rate of $1 per 1,000 cu. ft.